THE PRACTICAL

COTTON SPINNER,

AND

MANUFACTURER.

THE PRACTICAL
COTTON SPINNER,
AND
MANUFACTURER:
THE
MANAGERS', OVERLOOKERS', AND MECHANICS' COMPANION.

A COMPREHENSIVE SYSTEM OF

CALCULATIONS OF MILL GEARING AND MACHINERY,

FROM THE PRIMARY MOVING POWER, THROUGH THE DIFFERENT PROCESSES OF

CARDING, DRAWING, SLUBBING, ROVING, SPINNING, AND WEAVING,

With the recent improvements in Machinery.

TO WHICH ARE ADDED,

Compendious Tables of Yarns and Reeds for Silk, Linen, Worsted, and Wool.

BY R. SCOTT.

Corrected and Enlarged, with Plates of American Machines,

BY OLIVER BYRNE,
CIVIL, MILITARY, AND MECHANICAL ENGINEER;
COMPILER AND EDITOR OF THE "DICTIONARY OF MACHINES, MECHANICS, ENGINE-WORK, AND ENGINEERING;" AUTHOR OF "THE PRACTICAL MODEL CALCULATOR," AUTHOR OF "THE COMPANION FOR MACHINISTS, MECHANICS, AND ENGINEERS;" AUTHOR AND INVENTOR OF A NEW SCIENCE, TERMED "THE CALCULUS OF FORM," A SUBSTITUTE FOR THE DIFFERENTIAL AND INTEGRAL CALCULUS; AND NUMEROUS OTHER MATHEMATICAL AND MECHANICAL WORKS, ETC. ETC. ETC.

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HENRY CAREY BAIRD,
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PREFACE.

SEVERAL publications on Cotton Spinning have appeared, the merits of which it is not my intention to discuss. As a practical working man, I may however observe, that those which have come under my notice are, to a considerable extent, destitute of much practical utility. The systems they contain of making the calculations, are not sufficiently explicit, and hence can never achieve the great and important object of combining practice with theory, which is so essential, particularly to managers and overlookers.

The present work contains every necessary calculation connected with the most recent improvements in the machinery employed in the spinning and manufacturing business. The rules, examples, and illustrations are simple and easily understood; so much so that any person having a knowledge of the elementary rules of arithmetic may, without difficulty, by a little attention to the rules and examples, prepare himself to fill the important situation of overlooker or manager in any department of the spinning and manufacturing business. The rules and examples are all original, and have been reduced to practice with great care.

Calculations relative to the machinery used in the spinning and manufacturing of all fibrous substances, are attainable by the rules established in this work, so that it will be found equally beneficial to those engaged in the spinning and manufacturing of silk, flax, worsted, and wool. Compendious tables are arranged, accompanied with rules, examples, and illustrations, to show the size, girt, hank, or proportion of hank, in every operation. The fineness of yarns according to the different lengths, constituting the lea, cut, or hank, with the different systems of counting worsted reeds, are added.

During my engagements for many years in the different departments of the cotton business, I found a great deficiency of theoretical knowledge among practical persons filling important situations in cotton and other factories. This led to the determination, at the request and by the encouragement of several friends, to prepare a complete system of calculations; and I have no hesitation in saying, that such a system will be found in the present work. And while it answers as a book of reference to the master, and an assistant to the manager, overlooker, and mechanic, it will convey instructions to the aspiring operative, and may be found a useful auxiliary in the tuition of young persons intended for the spinning, manufacturing, or machine business. This work will not only be found to convey a correct knowledge of its appropriate calculations, but, in following out the rules here laid down, a considerable degree of pleasure must be experienced when it is found that theory and practice are so beautifully combined, and that it will enable persons to give general satisfaction in the management of their respective departments of this peculiarly important business.

It has been remarked, that "the country which parts with the raw materials of labor, is afterwards bereft of the sustenance of man—food goes away to visit industry, and hunger remains to dwell with idleness, and famine descends, with all its terrors, to castigate the folly which blindly relinquishes the material of manufactures."

Foreign manufactures are the destruction of any country; and we believe, the people may stop or retard that destruction by superseding such manufactures, by producing articles equally good and cheap. A divided people, it is manifest, cannot purchase victory in war; the industrial prosperity of peace is equally impossible to a people who are at war with each other. Besides—let us not blink the truth—the nations that have distinguished themselves in industry and commerce, had always first distinguished themselves in arms for freedom. When the Persian was chased from the shores of Greece like a wolf, the republican Greek became a great trader.

The Saracens' conquests gave place to their commerce; after the scimitar came the shuttle. The Dutch laid down the arquebuse to assume the tiller. The Italians of their republican ages relieved guard alternately at the rich loom and the Goth-defying bastion.

However, it requires not a prophet's inspiration to foretell that the day is fast approaching when none but the superabundant raw material will be shipped from this country. The South and West have made more than a beginning in manufacturing their own cotton, iron, hemp, flax, &c., and the North and East can more than vie with Europe in wonder-working machinery. I have held these opinions for some time, and am much strengthened in them, on reviewing the vast improvements introduced into the cotton manufacturing business by American machinists and engineers. I may particularize the Niagara Throstle, or McCulley's patented improved Spinning Frame; Mason's Self-acting Mule; Judkin's Heddle Machine. Respecting these machines we have entered into particulars, and have given large working drawings of them.

I should have mentioned the Cop-spinner of Dodge and Sons, of Dodgeville, Attleborough, Massachusetts. This first class machine will wind the yarn as fast as twisted, or when properly twisted, upon each of the spindles in a regular or proper shaped cop, which shall have a binding thread between each two adjacent layers of yarn, which prevents the cop from falling apart while being removed from the spindle.

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THE
PRACTICAL COTTON SPINNER
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MANUFACTURER.

MILL GEERING.

OPINIONS relative to the best speeds for machinery may differ; however, the following speeds are such as are generally adapted to machines spinning medium numbers; but all machinery must be speeded according to the quantity required.

RULES FOR WORKING SPEEDS OF SHAFTS.

Multiply the strokes of the steam engine, or revolutions of the waterwheel, by the number of teeth in the wheel fixed on the first moving power, or given shaft, for a dividend, and divide by the number of teeth in the wheel fixed on the intended driven shaft, and the quotient will be the speed or revolutions of shaft required.

To find the speed of any given shaft, when the speeds of the intermediate shafts are not required.

Multiply all the driving wheels together respectively, so far as the shaft you want the speed of, and that product by the strokes of the engine, the revolutions of the waterwheel, or any shaft: the speed being known for a dividend, then multiply all the driven wheels together accordingly, for a divisor, and the quotient will be the speed, or revolutions of the shaft required.

If a steam-engine makes 22 double strokes a minute (that is the same as to make the crank revolve 22 times a minute) with a wheel fixed on the crank, or fly-shaft, containing 106 teeth; what revolutions will the first or main line of shafts make, if the wheel with 106 teeth works into a wheel on the first or main line of shafts with 47 teeth?

22 strokes or revolutions each minute.
106 teeth in wheel of crank or fly-shaft.

132
220

Teeth of wheel on main line of shaft } 47)2332(49.617 revolutions a minute of first or main line of shafts.
188

452
423

290
282

80
47

330
329

1

If a wheel with 61 teeth be fixed on the first or main line of shafts, which makes 49.617 revolutions a minute; what revolutions a minute will a cross-shaft make with a wheel 57 teeth fixed on it, worked by the wheel with 61 teeth?

49.617 revolutions of shaft a minute.
61 teeth in wheel or shaft.

49617
297702

Teeth of wheel on cross-shaft } 57)3026.637(53.098894 revolutions of cross-shaft a minute, or 53.1—nearly.
285

176
171

563
513

507
456

510
456

540
513

270
228

42

If a wheel with 75 teeth be fixed on a shaft revolving 49.617 times a minute, works into a wheel with 41 teeth, fixed on a shaft for driving looms; what number of revolutions will it make a minute?

49.617 revolutions of shaft a min.
75
248085
347319
Teeth of wheel on shaft for driving looms } 41)3721.275(90.7628 revolutions a minute of shaft driving looms.
369
312
287
257
246
115
82
330
328
2

If a wheel with 52 teeth be fixed on a shaft making 90.7626 revolutions a minute, works into a wheel with 41 teeth, on the foot of an upright-shaft for driving mules; what revolutions a minute will the upright-shaft make?

90.7628 revolutions of shaft a minute.
52 teeth of wheel on shaft.
1815256
4538140
47196656

Teeth of wheel on foot of upright-shaft, } 41)47196656(115.1138 revolutions a minute of upright-shaft, driving mules.
41

61
41

209
205

46
41

56
41

155
123

326
328—nearly.

If a drum, 20 inches diameter, be fixed on an upright-shaft, for driving mules, which makes 115.1138 revolutions a minute; what revolutions will the upright-shaft in wheelhouse for driving rim or fly-shaft make, if a pulley, 12 inches in diameter, be fixed on a shaft, and worked by a strap from the drum 20 inches diameter?

115.1138 revolutions a minute, upright-shaft.
20 inches diameter of drum on shaft.

Inches diam. of pulley on upright-shaft in wheelhouse, } 12)2302.2760

191.8563 revolutions of upright-shaft a minute in wheelhouse, for driving rim-shaft.

If a wheel with 61 teeth be fixed on the first or main line of shafts, making 49.617 revolutions a minute; what number of revolutions will an upright-shaft make, with a wheel 57 teeth fixed on it, worked by the wheel of 61 teeth?

49.617 revol. a min. of main-shaft.
Teeth in wheel on main-shaft working into wheel on foot of upright-shaft, ... 61

49617
297702

Teeth of wheel on foot of upright-shaft, 57)3026637(53.098894 revols. a minute of upright-shafts.
285

176
171

563
513

507
456

510
456

540
513

270
228

42

If a wheel with 70 teeth be fixed on the top of an upright-shaft making 53.098894 revolutions a minute, and works into a wheel with 39 teeth on a lying-shaft; what revolutions will the lying-shaft make a minute?

53.098894 revols. of upright-shaft a minute.
70 teeth in wheel on upright-shaft.

3716.922580

Teeth of wheel on lying-shaft, } 39)3716.922580(95.3057 revolutions of lying-shaft the minute.
351
206
195
119
117
222
195
275
273
2

If a drum 30 inches diameter be fixed on a shaft making 95.3057 revolutions a minute; what number of revolutions a minute will a shaft make with a drum fixed on it 18 inches diameter, worked by a strap from the drum 30 inches diameter?

95.3057 revolutions of shaft a minute.
30 inches diam. of drum.

Inches diam. of drum, } 18)285.91710(158.8428 revolutions of shaft a minute.
18
105
90
159
144
151
144
77
72
51
36

150
144
6

If a drum 45½ inches diameter be fixed on a shaft making 95.30558 revolutions a minute; what number of revolutions a minute will a shaft make with a pulley fixed on it 13¾ inches diameter, and driven by a strap from the drum 45½ inches diameter?

95.30558 revolutions of shaft.
45.5 diameter of drum.

47652790
47652790
38122232

Inches diam. of pulley, } 13.75)4336.403890(315.3748 revols. of counter-shafts a minute, driving blowing and lap machines.
4125

2114
1375

7390
6875

5153
4125

10288
9625

6639
5500

11390
11000

390

If a drum 36 inches diameter be fixed on a shaft making 315.3748 revolutions a minute; what number of revolutions will the beaters of a blowing machine make, if a pulley 6 inches diameter be fixed on the end of the beaters, and driven by a strap from the drum 36 inches diameter?

315.3748 revolutions of counter-shaft a minute.
36 inches diameter of drum on shaft.

18922488
9461244

Diam. of pulley on beaters, 6 inches, } 113534928

1892.2488 revolutions of beaters a minute.

If a wheel with 62 teeth be fixed on a shaft making 53.098894 revolutions a minute; what number of revolutions will a shaft make with a wheel 46 teeth fixed on it, and driven by the wheel with 62 teeth?

53.098894 revolutions of given shaft a minute.
62 teeth in wheel on given shaft.

106197788
318593364

Teeth of wheel on shaft, } 46)3292.131428(71.568074 revolutions of shaft a minute.
322

72
46

261
230

313
276

371
368

342
322

208
184

24

If a wheel with 63 teeth be fixed on a shaft making 71.568074 revolutions a minute; what number of revolutions will a shaft make with a wheel of 45 teeth fixed on it, and driven by the wheel of 63 teeth?

71.568074 revolutions of shaft a min.
63 teeth in wheel.

214704222
429408444

Teeth of wheel on shaft, 45)4508.788662(100.1953 revolutions of shft. a minute driving looms.
45

087
45

428
405

238
225

136
135

1

If a wheel with 49 teeth be fixed on a shaft making 100.1953 revolutions per minute, drives a wheel of 38 teeth, fixed on foot of upright-shaft; what revolutions will the upright-shaft make a minute?

100.1953 revol. of given shaft a minute.
Teeth of wheel on shaft 49

9017577
4007812

Teeth of wheel on foot of upright-shaft, 38)4909.5697(129.2 revolutions of upright-shaft a minute—Spinning-room.
38

110
76

349 76
342 78—nearly.

If a drum 21 inches diameter be fixed on an upright-shaft, for driving upright-shaft in wheelhouse, making 129.2 revolutions a minute; what number of revolutions a minute will the upright-shaft in wheelhouse make, with a pulley 14 inches diameter fixed on it?

129.2 revol. a min. of upright-shaft.
21 inches diameter of drum on it.

1292
2584

Inches diam. of pulley, 14)2713.2(193.8 revolutions of upright-shaft in wheelhouse a minute, working rim or fly-shafts.
14

131
126

53
42

112
112

If a wheel with 60 teeth, fixed on a shaft, makes 53.098894 revolutions a minute; what number of revolutions per minute will an upright-shaft make, with a wheel of 44 teeth fixed on its foot, and driven by the wheel of 60 teeth?

53.098894 revolutions a minute.
60 teeth wheel.

Teeth of wheel on foot of upright-shaft, 44)3185.933640(72.40758 revol. of upright-shaft a min., for Dressing-room.
308

105
88

179
176

333
308

256
220

364
352

12

Or thus, dividing by 4 and 11 for 44.

4 { 3185.93364

11 { 79648341

72.40758—12

If an upright-shaft makes 72.40758 revolutions a minute, with a wheel of 75 teeth fixed on top, working into a wheel of 41 teeth, fixed on a lying-shaft; what revolutions a minute will the lying-shaft make?

72.40758 revols. of upright-shaft a min.
75 teeth of wheel.

36203790
50685306

Teeth of wheel on lying-shaft, } 41)54.3056850(132.4529 revolutions a min. of shaft driving Dressing-frame.
41

133
123

100
82

185
164

216
205

118
82

365
369—nearly.

The speed of any shaft may be obtained, without ascertaining the speeds of the intermediate shafts, by the following

RULE.

Multiply the number of double strokes of the steam-engine, or the number of revolutions of any given shaft per minute by the number of teeth in the driving-wheels respectively, or, if drums or pulleys, by the inches in the diameters respectively, or in the place they occur, for a dividend, and all the driven-wheels, drums, or pulleys, in the same manner, for a divisor, and the quotient will be the speed of the shaft required.

If a steam-engine be making 22 double strokes or revolutions a minute, with the following driving and driven-wheels, drums, and pulleys; what number of revolutions a minute will the shaft make which is intended to drive a blowing machine or scutcher?

DRIVING.	DRIVEN.
Revolutions a minute, crank or fly-shaft 22.	Wheel on first lying-shaft 47 teeth.
Wheel on crank or fly-shaft 106 teeth.	Wheel top of upright-shaft 57 teeth.
Wheel on first lying-shaft, driving upright-shaft 61 teeth.	Wheel on next lying-shaft, 39 teeth.
Wheel on top of upright-shaft 70 teeth.	Diameter of pulley on shaft for driving blowing machine 13¾ inches.
Diameter of drum on shaft 45½ inches.	

```
      22 revolutions a minute crank or fly-shaft.
     106 teeth in wheel on crank-shaft.
    ----
     132
    220
    ----
    2332
      61 teeth in wheel on first lying-shaft, driving
    ----                                upright-shaft.
    2332
   13992
  ------
  142252
       70 teeth in wheel on top of upright-shaft.
  -------
  9957640
     45.5 or 45½ inches diameter of drum on shaft.
  -------
 49788200
49788200
39830560
---------
453072620.0 dividend.
```

```
             47 teeth in wheel on first line of shafts.
             57 teeth in wheel on foot of upright-shaft.
            ---
            329
           235
           ----
           2679
             39 teeth in wheel on second lying-shaft.
          -----
          24111
          8037
         ------
         104481
          13.75 or 13¾ inches diameter of pulley on shaft
         ------ for driving blowing machines.
         522405
        731367
       313443
      104481
      ----------
      1436613.75 divisor.

1436613.75)453072620.0(315.375388 revolutions a minute, shaft
           430984125                    driving blowing machine.
           ---------
            220884950
            143661375
            ---------
             772235750
             718306875
             ---------
              539288750
              430984125
              ----------
              1083046250
              1005629625
              ----------
                774166250        1276096250
                718306875        1149291000
                ---------        ----------
                 558593750        1268052500
                 430984125        1149291000
                 ----------        ---------
                 1276096250         118761500
```

N. B.—The small difference arising in the above system of working, is on account of working all the different speeds of shafts separately. (See former Examples.)

If a drum 45½ inches diameter be fixed on a shaft making 315.375388 revolutions a minute; what number of revolutions will the beater of a blowing machine make, with a pulley fixed on the beater end, 10 inches diameter, and driven by a strap from the drum 45½ inches diameter?

315.375388 revolutions of shaft a minute.
45.5 or 45½ inches diam. of drum.

1576876940
1576876940
1261501552

Inches diam. of pulley on beater end, } 10)14349.5801540

1434.9580154 revolutions of beater a min.

If a shaft makes 84 revolutions a minute, with a wheel of 60 teeth fixed on it, working into a wheel on a cross or upright-shaft, with 52 teeth; what number of revolutions will the cross or upright-shaft make?

84 revolutions of shaft a minute.
60 teeth in wheel on shaft.

Teeth of wheel on cross or upright-shaft, } 52)5040(96.923 revols. of cross or upright-shaft a minute.
468

360
312

480
468

120
104

160
156

4

If a cross or upright-shaft be making 96.923 revolutions a minute, with a wheel of 52 teeth fixed on it, which is driven by a wheel with 60 teeth fixed on the lying-shaft; what number of revolutions will the lying-shaft make a minute?

96.923 revols. a min. of cross or upright-shaft.
52 teeth of wheel fixed on shaft.

193846
484615

Teeth of wheel on lying shft. } 60)5039.996(84 nearly, revolutions of lying-shaft.
480

239
240—nearly.

If a drum 18 inches diameter be fixed on a shaft making 96.923 revolutions a minute; what number of revolutions will the main cylinder of a carding-engine make, with a pulley fixed on the cylinder end 15 inches diameter, and driven by a strap from the drum 18 inches diameter?

96.923 revols. a min. of shaft.
18 inches diam. of drum.

775384
96923

Inches diameter of pulley on cylinder end, } 15)1744.614(116.3 revols. of main cylinder a min.
15

24
15

94
90

46
45

1

Required the diameter of a pulley to make 116.3 revolutions a minute; the drum fixed on the shaft being 18 inches diameter, making 96.923 revolutions a minute:—

96.923 revolutions of shaft a minute.
18 inches diameter of drum.

775384
96923

Revols. required 116.3)1744.614(15 in. diam. of pulley required.
1163

5816
5815

1

N. B.—The speed of any piece of machinery may be ascertained, according to the foregoing Rules and Examples.

The speed of a counter-shaft is required, the following particulars being given:—

First shaft 96 revolutions a minute.—Drum on said shaft 18 inches diameter.—Drum on second shaft 14 inches diameter.—Drum on the second shaft for driving the third shaft 10 inches diameter.—Drum on the third shaft 9 inches diameter.

Drum on 2d shaft 14 inches diameter.
Drum on 3d shaft 9 inches diameter.

126 divisor.

96 revolutions of shaft a minute.
18 inches diameter of drum on this shaft.

768
96

1728
10 inches diameter of drum on 2d shaft.

17280

```
126)17280(137.14 revols. of counter-shaft a min.
    126
    ———
     468
     378
     ———
      900
      882
      ———
       180
       126
       ———
        540
        504
        ———
         36
```

MIXING COTTON.

On account of the many varieties and variations even of the same kinds of cotton, it will be found best to mix a number of bales or bags together; arranging them properly in the place appropriated for the purpose, which done, proceed to throw abroad one bale or bag, covering as much surface as convenience will allow, according to the number intended to be mixed, and proceed till the last is thrown on your stock, treading it well down as you proceed. When wanted for use, rake it down with a rake, similar to a garden rake, regularly from the top to the bottom; this process will be found not only to mix it regularly, but will open the cotton considerably, which is very essential, prior to being put through the first preparatory piece of machinery.

In all cases it is best to mix as great a number of bales or bags of cotton as can be done conveniently; because, whenever there is a fresh mixing of cotton, it is almost sure to require an alteration in some of the machinery, as it seldom happens that the new mixing will produce the same weight of roving or yarn.

MACHINERY.

In treating on machinery, the rules and examples will be laid down in the most easy, plain, and simple manner, so that persons possessing only a knowledge of the fundamental rules of arithmetic, will be able to comprehend them: and by following the rules, examples, and illustrations laid down, they will be able to acquire every qualification requisite, so far as regards calculations, for persons filling the important situations of managers or overlookers in any or every department of cotton manufacturing.

In the succeeding calculations, all common fractions, as far as possible, are omitted, and decimal fractions used. A knowledge of decimals may be easily obtained from almost any work on Arithmetic; but the best for the mechanic is the *Practical Model Calculator*, by the editor of this work, Oliver Byrne.

WILLOW.

Willows are generally used for opening the cotton, and taking out the heavy dirt. They are of various constructions. The one of which the following are the particulars, is of recent construction:—

A square cylinder measuring 30 inches from angle to angle.
4 strips, one at each corner, 4 inches by 3½ inches.
4 strips on the top corners, 4 inches by 3½ inches.
8 teeth or pins in each strip on the cylinder, at a regular distance from each other.
7 teeth in each strip on the top, or cover, and set opposite the centre of the spaces.
Distance of teeth 4 inches; length of teeth 4 inches.
Diameter of teeth at bottom 1 inch, regularly tapering to ⅜ inch.
Circular iron grate bars, or rods, half inch distant from each other.

The time for the cotton remaining in the willow is governed by wheel-work; one of the wheels has a pin fixed in it, and every time it revolves, works upon a spring connected with a lever, which opens the lid and discharges the cotton.

N. B.—It is customary with some to take off the wheels, having the lid continually down, consequently, the cotton thrown in will only revolve once or twice, before being discharged.

This system is adopted by the probability of the cotton being strung, by being too long detained in the machine.

If the shaft for driving a willow makes 158.84 revolutions a minute, with a drum fixed on it 26 inches diameter, and the pulley on the end of willow cylinder be 12 inches diameter; what number of revolutions will the cylinder make a minute?

158.84 revolutions of shaft a min.
26 inches diam. of drum on shaft.

95304
31768

Inches diameter of pulley on willow-cylinder end, } 12)4129.84

344.15333 revols. a min. of cylinder.

BLOWING MACHINE WITH TWO BEATERS.

Shaft for driving blowing machine 315.374 revolutions a min. Drum on said shaft 45.5 inches diameter. Pulley on beater ends 10 inches diameter.

315.374 revolutions of shaft a min.
45.5 inches diam. of drum on shaft.

1576870
1576870
1261496

Inches diameter of pulley on beaters, } 10)14349.5170

1434.9517 revols. of beater at blowing machine a minute.

If a pulley 4.75 inches diameter be fixed on the end of a beater, making 1535 revolutions a minute; what number of revolutions a minute will a shaft make, with a pulley fixed on it 31 inches diameter, and driven by a strap from the pulley 4.75 inches diameter?

1435 revolutions of beater a minute.
4.75 in. diam. of pul. on beater end.

7175
10045
5740

Inches diameter of pulley on under-shaft, 31)6816.25(219.879 revols. of shaft a min.
62
61
31
306
279
272
248
245
217
280
279
1

If a wheel with 14 teeth be fixed on the end of the shaft at blowing machine, making 219.879 revolutions a minute; what number of revolutions a minute will a shaft make with a wheel of 88 teeth, fixed on the end, and driven by a wheel of 14 teeth?

219.879 revolutions of given shaft a min.
14 teeth wheel on end of shaft.

879516
219879

3078.306

Teeth of wheel on geering-shaft, } 88)3078.306(34.98 revols. of geering-shaft a minute.
264
———
438
352
———
863
792
———
710
704
———
6

If a wheel with 35 teeth be fixed on the other end of geering-shaft, working into wheel 35 teeth on bottom of bevil-shaft, and a wheel 35 teeth on the top of bevil-shaft, be working into a wheel 60 teeth on the end of creeper, or delivering-roller; what revolutions will the creeper, or delivering-roller make a minute?

34.98 revols. of geering-shaft a min.
35 teeth wheel on top of bevil-shaft.
———
17490
10494
———
Teeth of wheel on end of creeper-roller, } 60)1224.30
———
20.405 revols. of creeper, or delivering-roller, a minute.

N. B.—The 35 *teeth wheels on end of geering-shaft, and bottom of bevil-shaft are omitted, on account of their being the same as carrying, or connecting wheels only.*

If a wheel of 18 teeth be fixed on creeper, or delivering-roller, making 20.405 revolutions a minute, working into a wheel on stud with 40 teeth, which works into a wheel of 64 teeth on another stud, which works into wheel of 96 teeth on the front, or second wire cylinder end; what number of revolutions will the cylinder make a minute?

N. B.—All the intermediate wheels between the creeper-roller and wheel on wire cylinder end are omitted in the operation, being only carrying, or connecting wheels, which, if made use of, must be considered as both driving and driven-wheels.

```
                                20.405 revols. of creeper-roller a min.
                                    18 teeth, wheel on end of roller.
                               ------
                               163240
                               20405
                               ------
Teeth of wheel on   }      96)367.290(3.826 nearly revols. 2d wire
wire cylinder end,  }         288              cylinder a minute.
                              ---
                               792
                               768
                               ---
                                249
                                192
                                ---
                                 570
                                 576—nearly.
```

If a wheel with 52 teeth be fixed on the end of geering-shaft, making 34.98 revolutions a minute, working into a wheel of 52 teeth (a shaft which is the length of the machine, for propelling the shafts of the feed-rollers); on the lying-shaft is a wheel with 50 teeth working into a wheel on the bottom of upright-shaft 40 teeth, and a wheel with 39 teeth on the top of upright-shaft, working into a wheel 82 teeth on the end of the feed-rollers; what number of revolutions will the feed-rollers make?

N. B.—The first two wheels, 52 *teeth each, are omitted, being only carrying or connecting wheels.*

When there are more than one driving and driven-wheels, multiply the revolutions a minute of your given shaft by the driving-wheels respectively for a dividend, and your driven-wheels (only) together for a divisor, and the quotient will be the revolutions a minute required.

34.98 revolutions of given shaft a minute.
50 teeth wheel first driver.

1749.00
39 teeth wheel top of upright-shaft working into wheel 82 teeth on roller end.

15741
5247

68211 dividend.

40 teeth wheel on bottom of upright-shaft.
82 teeth wheel on feed-roller end.

3280 divisor.

3280)68211(20.796 revols. a min. of 2d feed-roller.
6560

26110
22960

31500
29520

19800
19680

120

If a wheel with 12 teeth be fixed on the end of the feed-rollers, making 20.793 revolutions a minute, works into a stud-wheel 26 teeth, which works into wheel 26 teeth on the first creeper-roller end; what number of revolutions a minute will the first creeper-roller make?

20.793 revols. of 2d feed-roller a min.
12 teeth in wheel on feed-roller.

Teeth of wheel on 1st creeper, } 26)249.516(9.6 revols. of 1st creeper-roller a minute.
234

155
156—nearly.

If a wheel with 16 teeth be fixed on the first creeper-roller, making 9.6 revolutions a minute, works into a stud-wheel 96 teeth (carrier), which works into wheel of 96 teeth on first wire cylinder end; what number of revolutions will the first wire cylinder make a minute?

9.6 revols. of first creeper-roller a min.
16 teeth-wheel fixed on first creeper-roller.

576
96

Teeth of wheel on 1st wire cyl. } 96)153.6(1.6 revols. of 1st wire cyl. a minute.
96

576
576

If a wheel with 40 teeth be fixed on a lying-shaft, making 34.98 revolutions a minute, works into a wheel 50 teeth on the bottom of an upright-shaft, and a wheel 40 teeth fixed on the top of upright-shaft works into wheel 82 teeth on end of feed-rollers; what number of revolutions will the first feed-roller make a minute?

Wheel on bottom of upright-shaft 50 teeth.
Wheel on 1st feed-roller end 82 teeth.

4100 divisor.

34.98 revolutions of lying-shaft a minute.
40 teeth wheel on lying-shaft.

1399.20
40 teeth wheel on top of upright-shaft.

4100)55968.00(13.65 revolutions of 1st feed-roller a min.
41

149
123

266
246

208
205

3

If a wheel with 12 teeth fixed on the end of feed-rollers, making 13.65 revolutions a minute, works into a wheel of 26 teeth on feed-cloth-roller; what number of revolutions a minute will the feed-cloth-roller make?

13.65 revols. of feed-roller a min.
12 teeth wheel on end.

Teeth of wheel on end of feed-cloth-roller, } 26)163.80(6.3 revols. of feed-cloth-roller a minute.
156

78
78

If the feed-cloth-roller be 3 inches diameter, making 6.3 revolutions a minute; how many inches will the feed-cloth traverse?

6.3 revols. of feed-cloth-roller a minute.
3 inches diameter of feed-cloth-roller.

18.9
3.1416 circumference when the diam. is 1.

1134
189
756
189
567

59.37624 inches feed-cloth traverses a min.

If the first creeper-roller be 3.5 inches diameter, making 9.6 revolutions a minute; how many inches will it traverse?

3.1416 circumference when the diameter is 1.
3.5 diameter of creeper-roller.

157080
94248

10.99560 inches circumference of creeper-roller.
9.6

6597360
9896040

105.557760 inches first creeper-roller traverses a min.

If the second feed-roller be 1.5 inch diameter, making 20.793 revolutions a minute; how many inches will it traverse?

3.1416 circumference when the diameter is 1.
1.5 diameter of feed-roller.

157080
31416

4.71240 inches circumference of feed-roller.
20.793

141372
424116
329868
942480

97.9849332, or nearly 98 inches feed-roller traverses a minute.

If the second creeper, or delivering-roller, be 3.5 inches diameter, making 20.405 revolutions a minute; how many inches will it traverse?

3.1416 circumference when the diameter is 1.
3.5 inches diameter of second creeper, or delivering-roller.

157080
94248

10.99560 inches circumference of second creeper, or delivering-rollers.
20.405

549780
4398240
2199120

224.3652180 inches creeper, or delivering-roller, traverses a minute.

N. B.—The draught of any piece of machinery may be ascertained by dividing the distances traversed, into each other, as will appear in a future part of this work.

DIMENSIONS AND MOTIONS OF A DOUBLE BLOWING MACHINE.

Beaters make 1435 revolutions a minute.
Feed-cloth-roller makes 6.3 revolutions a minute.
First feed-roller makes 13.65 revolutions a minute.
First creeper-roller makes 9.6 revolutions a minute.
First wire cylinder makes 1.6 revolutions a minute.
Second feed-roller makes 20.8 revolutions a minute.
Second creeper, or delivering-roller, in the front of machine, makes 20.405 revolutions a minute.
Second wire cylinder makes 4.888 revolutions a minute.
Distance of grate-bars from each other $\frac{1}{2}$ an inch.
Distance of grate-bars from beaters $1\frac{1}{4}$ to $\frac{1}{2}$ an inch.
Diameter of beaters 18 inches.
Diameter of feed-cloth-rollers 3 inches.
Diameter of iron-feed-rollers $1\frac{1}{2}$ inch.
Diameter of plain iron-rollers 2 inches.
Diameter of creeper-rollers $3\frac{1}{2}$ inches.
Diameter of wire cylinder 22 inches.

N. B.—The rollers not named a second time are of the same dimensions as those above.

Feed-cloth-roller traverses 59.37624 inches a minute.
First creeper-roller traverses 105.55776 inches a minute.
Second feed-roller traverses 98 inches a minute—nearly.
Second creeper, or delivering-roller, traverses 224.365218 inches a minute.

N. B.—The above particulars will materially differ from some blowing machines, but the particulars of any machine may be found by following the examples and illustrations laid down.

LAP MACHINE.

It has become very general of late years to have two lap machines, in place of a blowing machine and a lap machine, and where it is the case, two or three laps from the first machine are put up at the second, which has a great tendency to equalize the lap, and produce more even carding; however, the following are the particulars where *only* a certain weight is fed on a given length of the feed-cloth without any doubling, but there will be little difference in the machine further than the difference at the feeding parts, or in the draughts of the machine.

If the shaft for driving a lap machine makes 315.3747 revolutions a minute, the drum on said shaft 40.5 inches diameter, and the pulley on the beater end 11.25 inches diameter; how many revolutions will the beater make a minute?

315.3747 revolutions of shaft a minute.
40.5

15768735
126149880

Inches diam. of pulley, } 11.25)12772.67535(1135.3489 revols. of beater a minute.
1125

1522
1125

3976
3375

6017
5625

3925
3375

5503
4500

10035
9000

10350
10125

225

If a pulley 4.75 inches diameter be fixed on the end of a beater making 1135.3489 revolutions a minute; what revolutions a minute will a shaft make with a pulley fixed on it 31.5 inches diameter, and driven by a strap from the pulley 4.75 inches diameter?

```
                        1135.3489 revolutions of beater a min.
                             4.75 in. diam. of pulley on beater
                        ---------                          end.
                         56767445
                        79474423
                       45413956
                       ------------
Inches diam. of  } 31.5)5392.907275(171.2 revols. of shaft work-
pulley on shaft, }      315                ing geering a minute.
                        ----
                        2242
                        2205
                       ------
                          379
                          315
                          ----
                           640
                           630
                           ----
                            10
```

If a wheel 14 teeth be fixed on shaft making 171.2 revolutions a minute, and works into a carrying-wheel with 30 teeth, which drives a wheel 88 teeth on geering-shaft; what number of revolutions a minute will the geering-shaft make.

```
                      171.2 revols. of shaft a min. working geering.
                         14 teeth wheel fixed on said shaft.
                     ------
                       6848
                      1712
Teeth of wheel  }    ------
on    geering-  } 88)2396.8(27.236 revols. a minute of geering-
shaft,          }    176                 shaft.
                     ----
                      636
                      616
                      ----
                       208
                       176
                       ----        560
                        320        528
                        264        ----
                        ----        32
```

If a wheel with 16 teeth be fixed on a shaft making 27.236 revolutions a minute, works into a wheel 88 teeth on the end of lap-roller; how many revolutions will the lap-roller make a minute?

27.236 revolutions of shaft a minute.
16 teeth wheel on said shaft.

163416
27236

Teeth of wheel on lap-roller, } 88)435.776(4.952 revols. of lap-roller a min.
352

837
792

457
440

176
176

N. B.—There is a wheel of 30 *teeth fixed on the first lap-roller, which works into a wheel* 20 *teeth on stud, which drives a wheel* 30 *teeth on the second lap-roller, consequently it will be the same speed as the first.*

If a wheel 22 teeth fixed on geering-shaft, make 27.236 revolutions a minute, works into a wheel 88 teeth on front iron-roller; what number of revolutions will the front iron-roller make a minute?

27.236 revols. of geering-shaft a min.
22 teeth wheel on geering-shaft.

54472
54472

Teeth of wheel on front iron-roller, } 88)599.192(6.809 revolutions of front iron-roller a minute.
528

711
704

792
792

If a wheel of 20 teeth fixed on the front iron-roller, making 6.809 revolutions a minute, works into a wheel of 19 teeth on stud, which works into a wheel of 19 teeth on creeper-roller; what number of revolutions will the creeper-roller make a minute?

6.809 revolutions of iron-rollers a min.
20 teeth wheel fixed on iron-rollers.

Teeth of wheel on creeper-roller, } 19)136.180(7.167 revol. of creeper-roller a minute.
133
31
19
128
114
140
133
7

If a wheel of 18 teeth fixed on the end of creeper-roller, making 7.167 revolutions a minute, works into a wheel with 64 teeth on stud, which works into a wheel of 96 teeth on wire cylinder end; what number of revolutions will the wire cylinder make a minute?

7.167 revols. of creeper-roller a min.
18 teeth wheel fixed on creeper-roller.

57336
7167

Teeth of wheel on wire cylinder, } 96)129.006(1.3438 revols. of wire cyl. a min.
96
330
288
420
384
780
366 768
288
12

If a wheel with 36 teeth, fixed on the end of the creeper-roller, making 7.167 revolutions a minute, works into a wheel with 36 teeth on feed-roller shaft, and on the other end of feed-roller shaft is a wheel with 46 teeth, which works into a wheel with 30 teeth on feed-roller end; what number of revolutions will the feed-rollers make a minute?

7.167 revols. of creeper-roller a min.
46 teeth on end of feed-roller shaft.

43002
28668

Teeth of wheel on feed-roller, } 30)329.682

10.9894 nearly 11 revolutions of feed-rollers a minute.

N. B.—The two 36 *teeth wheels are not noticed, the one being a driver, and the other driven.*

If a wheel with 12 teeth fixed on feed-rollers, making 10.9894 revolutions a minute, works into a stud-wheel of 26 teeth, working into wheel of 26 teeth on feed-cloth-roller end; what number of revolutions will the feed-cloth-roller make a minute?

10.9894 revols. of feed-roller a min.
12 teeth wheel on feed-rollers.

Teeth of wheel on feed-cloth-roller, } 26)131.8728(5.072 revols. of feed-cloth-roller a minute.
130

187
182

52
52

What number of inches will the feed-cloth traverse a minute, if the diameter of feed-cloth-roller be 3 inches, making 5.072 revolutions a minute?

N. B.—To find the circumference of wheels, drums, pulleys, rollers, &c., multiply the diameters by 3.1416, *which is equal to the circumference when the diameter is* 1.

```
    5.072 revols. of feed-cloth-roller a min.
        3 inches diameter of feed-cloth-rol.
   ------
   15.216
   3.1416
   ------
    91296
   15216
  60864
 15216
45648
---------
47.8025856 being rather more than 47¾ in.
           feed-cloth traverses a minute.
```

If the feed-rollers of lap machine be $1\frac{1}{2}$ inch diameter, making 10.9894 revolutions a minute; what number of inches will they traverse a minute?

```
   10.9894 revolutions of feed-rollers a min.
       1.5 inch diameter of feed-rollers.
   -------
    549470
   109894
   -------
   16.48410
     3.1416 circumference when the diam. is 1.
   --------
     989046
    164841
   659364
  164841
 494523
 ----------
 51.78644856 inches feed-rols. traverse a min.
```

What is the draught between feed-cloth and feed-rollers, from the two preceding examples?

4

Inches feed-cloth traverses. Inches feed-rollers traverse.
47.8025856)51.78644856(1.083 inch draught between feed-cloth and feed-roller.
478025856
3983862960
3824206848
1596561120
1434077568
162483552

If the creeper-roller at lap machine be 3½ inches diameter, making 7.167 revolutions a minute; what number of inches will it traverse in a minute?

7.167 revolutions of creeper-roller a minute.
3.5 inches diameter of creeper-roller.
35835
21501
25.0845
3.1416 equal to circumference when diam. is 1.
1505070
250845
1003380
250845
752535
78.80546520 inches creeper traverses a minute.

Required the draught between the feed-rollers and the creeper; the feed-rollers traversing 51.78644856 inches a minute, and the creeper the same as in the preceding example.

Inches feed-rollers traverse. Inches the creeper traverses.
51.78644856)78.80546520(1.5217 draught between feed-roller and creeper-rollers.
5178644856

27019016640
25893224280

11257923600
10357289712

9006338880
5178644856

38276940240
36250513992

2026426248

If the iron-roller in front of lap machine be $3\frac{15}{16}$ inches diameter, making 6.809 revolutions a minute; what number of inches will it traverse a minute?

$16\left\{\begin{array}{l} 4)15.00 \\ 4)3.75 \end{array}\right.$ decimal of $\frac{15}{16}$ = .9375

inches. 6.809 revols. of iron-rol. a min.
.9375 therefore $=3\frac{15}{16}=$ 3.9375 inches diam. on iron-rol.

34045
47663
20427
61281
20427

26.8104375
3.1416 circum. when diam. is 1.

1608626250
268104375
1072417500
268104375
804313125

84.22767045000 inches, or $84\frac{1}{4}$ inches nearly, iron-roller front of lap machine traverses a minute.

Required the draught between creeper-roller and iron-roller, from the preceding examples.

Inches. Inches.
78.8)84.22767(1.068 draught between creeper-roller
788 and iron-roller at lap machine.

5427
4728

6996
6304

6927
6304

623

N. B.—It is not practically necessary or requisite to carry any examples to more than 3 or 4 decimal figures, however they may occur in multiplying; but they may be used if thought proper in dividing.

If the lap-roller be 6½ inches diameter, making 4.952 revolutions a minute; how many inches will it traverse a minute?

4.952 revolutions of lap-roller a minute.
6.5 inches diameter of lap-roller.

24760
29712

32.1880
3.1416

193128
32188
128752
32188
96564

101.1218208 inches lap-roller traverses a minute.

Required the draught between the iron-roller and the lap-roller, from the preceding examples.

Inches. Inches lap-roller traverses a minute.
84.2276)101.1218208(1.2 draught between iron-roller and
842276 lap-roller.

1689422
1684552

4870

The total draught at the lap machine may be ascertained by multiplying the different draughts into each other:

OR,

By multiplying all the driving-wheels together, beginning at the wheels driving the lap-roller, and taking them respectively (except the driving and driven-wheels, which, being of the same number of teeth, are omitted) to the feed-cloth-roller, the product of which must be multiplied by the diameter of the feed-cloth-roller, for a divisor, and all the driven-wheels multiplied in the same manner, the products of which must be multiplied by the diameter of the lap-roller for a dividend, and the quotient will be the draught, as in the following examples:—

Draught between feed-cloth and feed-rollers 1.08.
Draught between feed-roller and creeper-roller 1.52.
Draught between creeper-roller and iron-roller 1.068.
Draught between iron-roller and lap-roller 1.2.

```
      1.08 draught between feed-cloth and feed-rollers.
      1.52 draught between feed-roller and creeper-roller.
      ----
       216
      540
     108
     -----
     1.6416
     1.0688 draught between creeper-roller and iron-roller.
     ------
     131328
    131328
    98496
   164160
  ----------
  1.75454208
         1.2 draught between iron-roller and lap-roller.
  ----------
   350908416
  175454208
  ----------
  2.105450496 total draught at lap machine.
```

THE SAME EXAMPLE AS LAST—BY WHEELS.

The first driven-wheel on lap-roller is 88 teeth, working into a wheel 16 teeth on the end of geering-shaft; then on the other end of geering-shaft there is a wheel with 22 teeth, working into a wheel with 88 teeth on iron-roller; on the other end of iron-roller a wheel with 20 teeth works into a wheel with 20 teeth on the top-roller, which works into a wheel with 20 teeth on a stud, which works into a wheel with 19 teeth on the creeper-roller end; on the other end of creeper-roller there is a wheel with 36 teeth, working into a wheel with 36 teeth on the end of the feed-roller-shaft; on the other end of the feed-roller-shaft there is a wheel with 46 teeth working into a wheel with 30 teeth on the end of the feed-roller; on the other end of the feed-roller there is a wheel with 12 teeth working into a wheel with 26 teeth on a stud, which works into a wheel with 26 teeth on the end of the feed-cloth-roller; the lap-roller is 6½ inches diameter, and the feed-cloth-roller 3 inches diameter; what is the draught at lap machine?

DRIVING-WHEELS.

88 teeth wheel on lap-roller.
22 teeth wheel on geering-shaft.

176
176

1936
20 teeth wheel on iron-roller.

38720
46 teeth wheel on feed-shaft.

232320
154880

1781120
12 teeth wheel on feed-roller.

21373440
3 inches diameter of feed-cloth-roller.

64120320 divisor.

N. B.—The carrying, or connecting wheels, and driving and driven-wheels working together, where they contain the same number of teeth, are omitted, as will be found in the preceding and following examples:—

DRIVEN-WHEELS.

16 teeth wheel on geering-shaft.
88 teeth wheel on iron-roller.

128
128

1408
19 teeth wheel on creeper-roller.

12672
1408

26752
30 teeth wheel on feed-roller.

802560
26 teeth wheel on feed-cloth-roller.

4815360
1605120

20866560
6.5 diameter of lap-roller.

104332800
125199360

135632640.0 dividend.

Divisor.
64120320)135632640(2.115 draught at lap machine.
128240640

73920000
64120320

97996800
64120320

338764800
320601600

18163200

N. B.—The small difference between the last two examples is in the method of working, arising from the decimal parts; however, working draughts by wheels, as in the last example, is the surest way where great accuracy (which is indispensable), is required.

The following are the particulars of a lap machine, where there are no doublings:—

Beater makes 1135.348 revolutions a minute.
Feed-cloth-roller makes 5.072 revolutions a minute.
Feed-rollers make 10.9894 revolutions a minute.
Creeper-roller makes 7.167 revolutions a minute.
Iron-rollers make 6.809 revolutions a minute.
Lap-rollers make 4.952 revolutions a minute.

Distance of grate-bars from each other $\frac{1}{2}$ an inch.
Distance of grate from beater 1 inch.
Diameter of beater 18 inches.
Diameter of feed-cloth-roller 3 inches.
Diameter of feed-rollers $1\frac{1}{2}$ inch.
Diameter of creeper-roller $3\frac{1}{2}$ inches.
Diameter of iron-rollers $3\frac{15}{16}$ inches.
Diameter of lap-rollers $6\frac{1}{2}$ inches.

Feed-cloth-roller traverses 47.7025856 inches a minute.
Feed-rollers traverse 51.78644856 inches a minute.
Creeper-rollers traverse 78.8054652 inches a minute.
Iron-rollers traverse 84.2276704 inches a minute.
Lap-rollers traverse 101.12182808 inches a minute.

Draught between feed-cloth and feed-rollers 1.108.
Draught between feed-rollers and creeper 1.52.
Draught between creeper and iron-rollers 1.0688.
Draught between iron-rollers and lap-rollers 1.2.

Total draught at lap machine 2.115.

CARDING-ENGINE.

Carding-engines are of various constructions, but the construction of machinery will make no difference in the system of calculation, as all the various speeds, &c., are ascertained from that part which first receives motion, which is without exception the main cylinder.

The opinions of persons connected with cotton carding are different; however, all nearly agree in the most essential points, that is, in having the cards true and sharpened to a diamond point, and whether worked with *rollers*, *rollers and clearers*, *rollers clearers* and part *flats*, or *all flats*, to have the wire set near as possible, so as not to touch each other, the first 3 or 4 flats set rather more on the heel, or back of card, for the purpose of detaining the heavy dirt. Some kinds of cotton require considerably more carding than others; however, it may be observed, that the less cotton is carded the better, so that the dirt is taken out, and the fibres laid straight, after which, the cotton by being continued in the cards is *only weakened*, consequently the yarns will be weakened in proportion, which must appear reasonable to any practical person.

If a shaft make 95.3057 revolutions a minute, with a drum fixed on it 16 inches diameter; what number of revolutions a minute will the main cylinder of a carding-engine make, with a pulley fixed on it 14 inches diameter, and driven with a strap from the drum 16 inches diameter?

95.3057 revolutions of shaft a minute.
16 inches diameter of drum.

5718342
953057

Inches diam. of pulley, } 14)1524.8912(109 revols. of main cylinder a minute.
14

124
126—nearly.

If the main cylinder of a carding-engine makes 108.92 revolutions a minute, with a wheel on its axis of 22 teeth, working into a wheel of 140 teeth on stud—on same stud there is a wheel of 32 teeth, working into a wheel of 130 teeth on a stud, which drives a wheel of 130 teeth on end of doffer-cylinder—what number of revolutions will the main cylinder make for the doffer-cylinder one, and what number of revolutions will the doffer-cylinder make a minute?

140 teeth wheel on stud.
130 teeth wheel on doffer-cylinder end.

4200
140

18200 divisor.

108.92 revolutions of main cylinder a min.
22 teeth wheel on axis of cylinder.

21784
21784

2396.24
32 teeth wheel on stud.

479248
718872

18200)76679.68(4.213 revols. of doffer-cylinder a min.
72800

38796
36400

23968
18200

57680
54600

3080

The revolutions of the main cylinder for the doffer-cylinder one, will be found by dividing the revolutions of the main cylinder by the revolutions of the doffer-cylinder.

Revols. of doffer-cyl. 4.213)108.92(25.85 revols. of main cyl. for
8426 doffer 1.

24660
21065

35950
33704

22460
21065

1395

The number of revolutions the main cylinder makes for the doffer-cylinder one, will be found by multiplying the driving-wheels together for a divisor, and the driven-wheels together for a dividend, as in the following example:—

DRIVING-WHEELS.

Wheel on cylinder end 22 teeth.
Wheel on stud 32 teeth.

44
66

704 divisor.

DRIVEN-WHEELS.

Wheel on stud 140 teeth.
Wheel on doffer-cylinder 130 teeth.

4200
140

18200 dividend.

704)18200(25.85 revols. main cylinder makes for
1408 doffer-cylinder 1.

4120
3520

6000 3680
5632 3520

160

What will the main cylinder of a carding-engine traverse a min. if it makes 108.92 revolutions, and its diameter be 37 inches?

108.92 revols. of main cyl. a minute.
37 inches diam. of main cylinder.

76244
32676

4030.04
3.1416 circum. when the diam. is 1.

2418024
403004
1612016
403004
1209012

1 foot = 12 in.)12660.773664 inches main cyl. trav. a minute.

1 yard = 3 feet)1055.064472 feet main cyl. trav. a minute.

351.688157333 yards main cyl. trav. a min.

What surface will the doffer-cyl. of a carding-engine traverse a minute, if it makes 4.213 revolutions, and is 18 inches diameter?

4.213 revolutions of doffer-cyl. a minute.
18 inches diameter of doffer-cylinder.

33704
4213

75.834
3.1416 circumference when the diam. is 1.

455004
75834
303336
75834
227502

1 foot = 12 in.)238.2400944 inches doffer-cyl. trav. a minute.

1 yard = 3 feet)19.8533412 feet doffer-cyl. trav. a minute.

6.6177804 yards doffer-cyl. trav. a minute.

How many feet of fillet, 2 inches wide, will it require to cover a doffer-cylinder 18 inches diameter, and 36 inches wide?

3.1416 circumference when the diam. is 1.
18 inches diameter of doffer-cylinder.

251328
31416

56.5488
36 inches width of doffer-cylinder.

3392928
1696464

Inches, width of fillet, 2)2035.7568 inches area of doffer-cylinder.

1 foot = 12 in.)1017.8784 inches of fillet required for cyl.

84.8232 or nearly 85 feet of fillet required for cylinder.

N. B.—By taking the taper off one end of the fillet, and putting it to the other end, nearly 5 *feet of fillet will be saved; consequently* 80 *feet of the above fillet will be sufficient to cover a cylinder of the above dimensions.*

Whatever the width of the fillet is, divide the number of inches in the area of the cylinder, by the width of the fillet, and the quotient will be the number of inches required to cover the cylinder; then deduct the inches in the circumference of the cylinder from the quotient, and the remainder will be the net length of fillet required.

N. B.—The circumference of the cylinder must only be deducted when the taper end is cut off the beginning of the fillet, and is intended to be put on at the other end.

How many feet of 1½ inch fillet will be required to cover a cylinder 18 inches diameter, and 36 inches wide?

3.1416 equal to circum. when diam. is 1.
18 inches diameter of cylinder.

251328
31416

56.5488 circumference of cylinder.
36 inches width of cylinder.

3392928
1696464

2035.7568
Deduct 56.5488 circumference of cylinder.

Inches width of fillet, 1.5)1979.2080(1319.472 inches of fillet required to cover the cylinder.
15

47
45

29
15

142
135

70
60

108
105

30
30

Or,

1 ft. = 12 in.)1319.472 inches.

1 yd. = 3 feet)109.956 or nearly 110 ft.

36.652 yds., nearly $36\frac{3}{4}$ yards.

Required the speed of the feed-rollers of a carding-engine, from the following particulars:—

Revolutions of doffer-cylinder a minute 4.213.
Wheel on doffer-cylinder end, driving feed-roller-shaft 28 teeth.
Wheel on feed-roller-shaft (doffer end) 28 teeth.
Wheel on feed-roller-shaft, driving feed-rollers 13 teeth.
Wheel on feed-roller end 128 teeth.

N. B.—The wheels 28 *teeth on the doffer-cylinder end, and feed-roller-shaft, may be omitted, the one being a driving and the other a driven-wheel.*

4.213 revols. of doffer-cyl. a minute.
13 teeth wheel on feed-roller shaft.

12639
4213

Teeth of wheel on feed-roller-shaft, } 128)54.769(.4278 revols. of feed-rols. a min.
512

356
256

1009
896

1130
1024

106

If the diameter of the feed-rollers be $1\frac{1}{2}$ inches, making .4278 revolutions a minute; how many inches will the feed-rollers traverse?

.4278 revolutions of feed-rollers a min.
1.5 inches diameter of feed-rollers.

21390
4278

.64170
3.1416 circumference when diameter is 1.

385020
64170
256680
64170
192510

2.015964730 or $2\frac{1}{66}$ inches nearly feed-rollers traverse a minute.

What length of lap will be required to supply a carding-engine 1 day, allowing it to work 10 hours (2 hours being allowed for stripping, grinding, &c.), if the feed-rollers traverse 2.01596472 inches a minute?

2.01596472 inches feed-rols. traverse a minute.
60 minutes = 1 hour.
120.95788320
10 hours = 1 day.
1209.57883200 inches, or nearly 100 feet 10 inches a day.

Required the weight of cotton to supply a carding-engine 1 day, the feed-rollers of which traverse over a surface equal to 1209.578832 inches, there being 24 ounces fed on 30 inches of feed-cloth at lap machine, and the draught at lap machine being 2.115.

oz. cotton.
Draught at lap machine, 2.115)24.000(11.347517 oz. weight of 30 inches of lap.
2115
2850
2115
7350
6345
10050
8460
15900
14805
10950
10575
3750
2115
16350
14805
1545

Feed-cloth at lap mach. 30 in.)1209.578832 in. feed-rols. trav.

40.3192944 number of feeds.
11.347517 oz. weight of 30 in. of lap.

2822350608
403192944
2015964720
2822350608
1612771776
1209578832
403192944
403192944

4)457.5238786320048 nearly $457\frac{1}{2}$ oz., or $28\frac{6}{10}$lbs. nearly.

4)114.3809696580012

28.5952424145003lbs.

OR,

Multiply the number of inches (say 30), on which 24 ounces weight of cotton is fed on the feed-cloth at lap machine, by the draught at lap machine, (draught 2.115,) and that sum by the number of ounces in 1lb. for a divisor, and the number of inches the feed-rollers traverse in one day, or 10 hours, by the number of ounces fed on 30 inches on feed-cloth at lap machine, for a dividend, and the quotient will be the pounds weight required to supply the engine.

2.115 draught at the lap machine.
30 inches length fed on feed-roller.

63.450
16 ounces make one pound.

380700
63450

1015.200 divisor.

```
          1209.578832 inches of lap required a day.
                   24 oz. weight fed on 30 inches of feed-
          ───────────             cloth at lap machine.
           4838315328
          2419157664
          ───────────
1015.2)29029.891968(28.5952 pounds a day.
        20304           16 ounces= 1 pound.
        ─────         ──────
         87258         35712
         81216         5952
         ─────         ──────
          60429        9.5232 oz.
          50760            4 qrs.=1 oz.
          ─────        ──────
           96691       2.0928 qrs.
           91368
           ─────
            53239
            50760
            ─────
             24796
             20304
             ─────
              4492
```

N. B.—The weight of cotton required to supply a preparation, must be according to the number of carding-engines. The weight consumed by one carding-engine, multiplied by the number of carding-engines in the preparation, will give the weight of cotton required.

What number of revolutions will the doffer-cylinder of a carding-engine make, for the feed-rollers 1, if the wheels on the doffer-cylinder end and feed-roller-shaft be the same; and on the other end of feed-roller-shaft, a wheel with 13 teeth, working into a wheel 128 teeth on feed-roller end?

```
Teeth of wheel on feed-shaft, 13)128(9.846 revols. of doffer-cyl. for
                                 117        feed-rollers 1.
                                 ───
                                 110
                                 104      80
                                 ───      78
                                  60      ──
                                  52       2
```

The speed of the lap-rollers at carding-engine is required from the following particulars:—

Revolutions of feed-rollers a minute, .4278; wheel on feed-roller end 17 teeth, working into a wheel 84 teeth on stud, which works into a wheel 46 teeth on lap-roller.

.4278 revolutions of feed-rollers.
17 teeth wheel on feed-rollers.

29946
4278

Teeth of wheel on lap-roller, } 46)7.2726(.1581 revols. of lap-rollers a min.
46

267
230

372
368

46
46

If the lap-roller makes .1581 revolutions a minute, and be $3\frac{3}{4}$ inches diameter; what number of inches will it traverse? .1581 × 3.75 = .592875 × 3.1416 = 1.8625761, or rather more than $1.\frac{17}{20}$ inches, lap-roller traverses a minute.

If the feed-rollers traverse 2.01596472 inches a minute, and the lap-rollers 1.862576 inches; what draught is there between the feed-rollers and lap-rollers?

1.862576 in.)2.01596472(1.082 draught between lap-rollers, and feed-rollers.
1862576

15338872
14900608

4382640
3725152

657488

OR,

The draught between the feed-rollers and lap-rollers is required from the following particulars:—

Wheel on end of feed-rollers 17 teeth, working into stud-wheel 84 teeth, which works into wheel 46 teeth on the end of lap-rollers?

Diameter of feed-rollers, 1½ inches.
Diameter of lap-rollers, 3¾ inches.

3.75 inches diameter of lap-rollers.
17 teeth in wheel on feed-rollers.
2625
375
63.75 divisor.

1.5 inches diameter of feed-rollers.
46 teeth wheel on lap-rollers.
90
60

63.75)69.00(1.0823 draught between lap-rollers and
63.75 feed-rollers.
52500
51000
15000
12750
22500
19125
3375

Required the draught between the feed-rollers and lap-rollers, from the following particulars:—

Revolution of feed-rollers a minute, .4278.
Revolution of lap-rollers a minute, .1581.
Diameter of feed-rollers, 1.5 inches.
Diameter of lap-rollers, 3.75 inches.

.1581 revolution of lap-rollers a minute.
3.75 inches diameter of lap-rollers.

7905
11067
4743

5.92875 divisor.

.4278 revolution of feed-rollers a minute.
1.5 inches diameter of feed-rollers.

21390
4278

5.92875)6.41700(1.082 draught between feed-rollers and lap-rollers.
592875

4882500
4743000

1395000
1185750

209250

What weight of cotton will be required to supply a carding-engine 1 day, or 10 hours, according to the following particulars?

Weight fed on 30 inches of feed-cloth at lap machine, 24 ounces.
Draught at lap machine 2.115.
Lap-roller traverses 1.862576 inches a minute.
60 minutes 1 hour.

111.754560
10 hours = 1 day.

1 foot = 12 in.)1117.545600 inches a day, lap-rol. traverses.

93.1288 feet a day, lap-roller traverses.

93.1288 feet of lap required a day.
24 oz. weight fed on 2½ feet, or 30 inches of feed-cloth at lap machine.

3725152
1862576

2235.0912 dividend.

2.115 draught at lap machine.
2.5 feet, or 30 in. feed-cloth at lap machine.

10575
4230

5.2875
16 ounces = 1 pound.

317250
52875

84.6000 divisor.

84.6)2235.0912(26 6½ weight of cotton required, to supply a carding-engine 1 day, or 10 hours.
1692

5430
5076

354
16 ounces 1 pound.

2124
354

84.6)5664(6 oz.
5076

588
4

84.6)2352(2 qrs.
1692

660

N. B.—If there had been no draught between the feed-rollers and lap-rollers, the weight of cotton required would have been 28 *pounds* 9½ *ounces.*

The speed of the calender-rollers, or delivering-balls, is required from the following particulars:—

Revolutions of doffer-cylinder a minute 4.213.

Wheel on doffer-cylinder end 130 teeth, working carrying-wheels, which works into a wheel of 28 teeth on delivering-ball-shaft.

4.213 revolutions of doffer-cylinder a min.
130 teeth wheel on doffer-cylinder.

126390
4213

Teeth of wheel on cal. ball-shaft, } 28)547.690(19.56 revolutions of delivering-balls a minute.
28

267
252

156
140

169
168

1

Required the speed of the calender-rollers, or delivering-balls, from the following particulars:—

Revolutions of main cylinder a minute, 108.92.
Wheel on axis of main cylinder, 22 teeth.
Wheel on stud, 140 teeth.
Wheel on stud, 32 teeth.
Wheel on doffer-cylinder end, 130 teeth.—(Working carriers.)
Wheel on delivering-ball-shaft, 28 teeth.

108.92 revolutions of main cylinder a minute.
22 teeth wheel on axis of main cylinder.

21784
21784

2396.24

2396.24
32 teeth wheel on stud.

479248
718872

76679.68 dividend.

140 teeth wheel on stud.
28 teeth wheel on delivering-ball-shaft.

1120
280

3920 divisor.

Divisor. Dividend.
3920)76679.68(19.56 revols. of delivering-balls a minute.
3920

37479
35280

21996
19600

23968
23520

448

If the calender-rollers, or delivering-balls, make 19.56 revolutions a minute, what number of inches, feet, and yards will it traverse, if their diameters be $3\frac{7}{8}$ inches?

3.1416 circumference when the diam. is 1.
3.875 diameter of delivering-balls.

157080
219912
251328
94248

12.1737000

12.1737000
19.56 revols. of delivering-balls a minute.

730422
608685
1095633
121737

1 ft. = 12 in.)238.117572 inches, delivering-balls traverse a min.

1 yd. = 3 ft.)19.843131 feet, delivering-balls traverse a min.

6.614377 yards, delivering-balls traverse a min.

Or, 6 yds. 1 ft. 10⅛ in. nearly, the delivering-balls traverse a min.

The speed of the licker-in is required from the following particulars:—

Revolutions of main cylinder a minute 108.92.
Diameter of pulley on cylinder, 14 inches.
Diameter of pulley on licker-in, 7 inches.

108.92 revols. of main cyl. a minute.
14 inches diameter of pulley.

43568
10892

Inches diam. of pul. on licker-in, 7)1524.88

217.84 revolutions of licker-in a min.

N. B.—The only utility of a licker-in is the preservation of the cards on the main cylinder, and whilst many approve of them, more disapprove of them.

The speed of the crank is required from the following particulars:—

Revolutions of main cylinder a minute, 108.92.
Diameter of pulley on cylinder for driving crank-shaft, 16 inches.
Diameter of pulley on crank-shaft, 7 inches.

108.92 revols. of main cyl. a minute.
16 inches diam. of pulley.

65352
10892

Inches diam. of pul. on crank-shaft, } 7)1742.72

248.96 or nearly 249 revolutions of crank-shaft a minute.

Required the draught of a carding-engine from the following particulars:—

Lap-rollers at carding-engine traverse 1.862576 inches a minute.
Calender-rollers, or delivering-balls, traverse 238.117572 inches a minute.

1.862576)238.117572(127.843 draught of carding-engine.
1862576

5185997
3725152

14608452
13038032

15704200
14900608

8035920
7450304

5856160
5587728

268432

Required the draught of a carding-engine from the following particulars:—

Wheel on calender or delivering-ball-shaft, 28 teeth.
Wheel on doffer-cylinder end, 130 teeth.
Wheel on feed-roller-shaft, 13 teeth.
Wheel on feed-rollers, 128 teeth.
Wheel on feed-roller end for driving lap-rollers, 17 teeth.
Wheel on lap-roller end, 46 teeth.
Diameter of calender or delivering-balls, 3.875 inches.
Diameter of lap-rollers, 3.75 inches.

N. B.—The carrying, or connecting wheels are omitted, as in former examples.

28 teeth wheel on delivering-ball-shaft.
13 teeth wheel on feed-roller-shaft.

84
28

364
17 teeth wheel on feed-roller end, driving lap-rollers.

2548
364

6188
3.75 inches diameter of lap-rollers.

30940
43316
18564

23205.00 divisor.

130 teeth wheel on doffer-cylinder.
128 teeth wheel on feed-rollers.

3840
128

16640
46 teeth wheel on end of lap-roller.

99840
66560

765440
3.875 diameter of delivering-balls.

3827200
5358080
6123520
2296320

2966080.000 dividend.

23205)2966080.000(127.8 draught of carding-engine.

23205

64558

46410

181480

162435

190450

185640

4810

If one preparation in the card-room requires 8 carding-engines, and each carding-engine delivers 238.117572 inches of carding a minute; what length will the whole preparation of carding-engines deliver in one day, allowing them to work 10 hours?

238.117572 in. of carding delivered a min. (1 engine).

60 minutes 1 hour.

14287.054320 inches delivered an hour. (1 engine.)

10 hours equal to 1 day.

142870.543200 inches delivered a day. (1 engine.)

8 carding-engines, one preparation.

inches.

1 ft.=12)1142964.345600 inches of carding delivered a day from 1 preparation.

1 yd.=3 ft.)95247.0288 feet of carding a day from 1 preparation.

31749.0096 yds. of carding a day from 1 preparation.

What length of lap will be required to supply 8 carding-engines 1 day, allowing them to produce 1142964.3456 inches of carding, and the draught at the carding-engine to be 128?

Inches of carding.
Draught at card. en. 128)1142964.3456(8929.4 inches of lap required.
1024
1189
1152
376
256
1204
1152
523
512
11

How many weighings of cotton must be fed on the lap machine, (each weighing fed on 30 inches of feed-cloth,) to produce 8929.4 inches of lap, allowing the draught at lap machine to be 2.115; and what weight of cotton will it require, allowing each weighing to be 24 ounces?

2.115 draught at lap machine.
30 inches length of feed.
63.450 in. of lap each weighing produces.

63.45)8929.4(140.731, nearly 140$\frac{3}{4}$ weighings of cotton required a day.
6345
25844
25380
46400
44415
19850
19035
8150
6345
1805

140.731 number of weighings of cotton required a day.
24 oz. weight of one weighing.
562924
281462
1 pound is 16 oz. } 4)3377.544
4) 844.386
211.0965 pounds, or 211 pounds 1½ oz. weight of cotton required a day for 1 preparation.
16 oz. 1 pound.
5790
965
1.5440
4 qrs.
2.1760

The foregoing examples are considered sufficient, because whatever principle may be considered best, the calculations must be made in the same way; the consumption and production, whether single and double carding, or for coarse or fine spinning, may be ascertained with the least trouble and greatest accuracy by a strict adherence to the rules and examples illustrated.

PARTICULARS OF A CARDING-ENGINE.

Speed of main-cylinder a minute 108.92 revolutions.
Speed of doffer-cylinder a minute 4.213 revolutions.
Speed of lap-rollers a minute 0.1581 revolutions.
Speed of feed-rollers a minute 0.4278 revolutions.
Speed of licker-in a minute 217.84 revolutions.
Speed of delivering-balls a minute 19.56 revolutions.
Speed of crank a minute 248.96 revolutions.
Diameter of main-cylinder 37 inches, traversing 12657.77 inches a minute.
Diameter of doffer-cylinder 18 inches, traversing 238.24 inches a minute.
Diameter of licker-in 9 inches, traversing 6159.29 inches a minute.

Diameter of lap-rollers 3¾ inches, traversing 1.862576 inches a minute.
Diameter of feed-rollers 1½ inches, traversing 2.016 inches a minute.
Diameter of delivering-balls 3⅞ inches, traversing 238.117572 inches a minute.
Diameter of pulley on main-cylinder 14 inches.
Diameter of pulley on main-cylinder for crank 16 inches.
Diameter of pulley on crank-shaft 7 inches.
Diameter of pulley for driving licker-in 14 inches.
Diameter of pulley on licker-in 7 inches.
Crank half radius 1⅞ inches, or 3¾ inches sweep.
Draught between lap-rollers and feed-rollers 1.08.
Total draught at carding-engine 128 nearly.
Weight of lap required to supply a carding-engine 1 day, or 10 hours 26 pounds 6½ ounces.
Length of carding delivered per engine a day 142870½ inches.
Length of lap consumed by 1 carding-engine a day 1117½ inches.

DRAWING-FRAME.

FIRST HEAD.

The shaft under the drawing-frame for driving drawing-boxes, makes 163.38 revolutions a minute.—Drums on shaft are 12 inches diameter.—Pulleys on the front rollers are 7 inches diameter; the speed of the front roller is required.

163.38 revols. of shaft a minute.
12 inches diam. of drums on shaft.

Inches diam. of pul. on front roller, } 6)1960.56

326.76 revolutions of front roller a min.

If the front roller of a drawing-frame makes 326.76 revolutions a minute, and its diameter be 1⅛ inches; what will it traverse?

326.76 revolutions of front roller a minute.
1.125 inches diameter of front roller.

163380
65352
32676
32676

367.60500

367.60500
3.1416 circumference when the diameter is 1.

2205630
367605
1470420
367605
1102815

1154.8678680 nearly 1155 inches, front roller traverses a minute.

The speed of shaft under rollers, for driving middle and back rollers, is required from the following particulars:—
Front roller makes 326.76 revolutions a minute.
Wheel on front roller for driving wheel on shaft 15 teeth.
Wheel on shaft under-rollers for driving middle and back rollers, 104 teeth.

326.76 revolutions of front roller a minute.
15 teeth wheel on front roller.

163380
32676

Teeth of wheel on shaft under rollers, } 104)4901.40(47.128 revols. of shaft under rols.
416

741
728

134
104

300
208

920
832

88

The speed of the middle roller is required from the following particulars:—

Revolutions of shaft under rollers 47.128 a minute.
Wheel on shaft for driving middle roller 90 teeth.
Wheel on middle roller 33 teeth.

47.128 revolutions of shaft under rollers [a min.
90 teeth wheel on do.

Teeth of wheel on mid. rol., } 33)4241.520(128.53 revolutions of middle roller a minute.
33
94
66
281
264
175
165
102
99
3

If the middle roller makes 128.53 revolutions a minute, and its diameter be $1\frac{1}{8}$ inches; what will it traverse?

128.53 revolutions of middle roller a minute.
1.125 inches diameter of roller.
64265
25706
12853
12853
144.59625
3.1416 circumference when the diameter is 1.
86757750
14459625
57838500
14459625
43378875
454.263579000 inches, middle roller traverses a minute.

The draught between the middle and front roller is required, from the following particulars:—

Front roller traverses 1154.867868 inches a minute.
Middle roller traverses 454.26358 inches a minute.

454.26358)1154.867868(2.542 draught between middle and
90852716 front roller.
246340708
227131790
192089180
181705432
103837480
90852716
12984764

The speed of the back roller is required, from the following particulars:—

Revolutions of shaft under rollers, 47.128 a minute.
Wheel on shaft for delivering back roller, 68 teeth.
Wheel on back roller, 56 teeth.

47.128 revols. of shaft under rols. a min.
68 teeth wheel on shaft.
377024
282768
Teeth of wheel on back roller, 56)3204.704(57.22685 revolutions of back rol.
280 a minute.
384
404 336
392
480
127 448
112
320
150 280
112
40

If the back roller makes 57.22585 revolutions a minute, and its diameter be $1\frac{1}{8}$ inches; what will it traverse?

57.22685 revols. of back roller a minute.
1.125 inches diam. of back roller.

28613425
11445370
5722685
5722685

64.38020625
3.1416 circumference when the diam. is 1.

38628123750
6438020625
25752082500
6438020625
19314061875

202.256855955000, or $202\frac{1}{4}$ inches, back roller traverses a minute.

The draught between the back and middle roller is required, from the following particulars:—

Middle roller traverses 454.26358 inches a minute.
Back roller traverses 202.25685 inches a minute.

202.25685)454.26358(2.24597 draught between back and middle roller.
40451370

49749880
40451370

92985100
80902740

120823600
101128425

196951750
182031165

149205850
141579795

7620055

N. B.—The total draught of any machine, where there are intermediate draughts, may be found by multiplying the draughts respectively into each other, the sum of which will be the total draught.

The draught may also be found by the wheels, as will appear hereafter.

The speed of the calender-rollers, or delivering-balls, is required from the following particulars:—

Front roller makes 326.76 revolutions a minute.
Wheel on front roller 38 teeth, working into carrying-wheels.
Wheel on calender, or delivering-ball-shaft, 100 teeth.

326.76 revols. of front roller a min.
38 teeth wheel on front roller.

261408
98028

Teeth of wheel on deliv.-ball-shaft, 100)12416.88

24.1688 revolutions of calender, or delivering-balls a minute.

The draught between the front roller and calender-rollers, or delivering-balls, is required from the following particulars:—
Front roller traverses 1155 inches a minute.
Calender, or delivering-balls trav. 1170.266 inches a minute.

1155)1170.266(1.013 draught between front roller and delivering-balls.
1155

1526
1155

3716
3465

251

If the calender, or delivering-balls make 24.1688 revolutions a minute, and their diameters be 3 inches; what will they traverse?

124.1688 revols. of delivering-balls a minute.
3 inches diameter of delivering-balls.

372.5064
3.1416 circumference when the diam. is 1.

22350384
3725064
14900256
3725064
11175192

1170.26610624 inches, calender-rollers, or delivering-balls traverse a minute.

The draught at the first head of a drawing-frame is required, from the following particulars:—

Back roller makes 57.22685 revolutions a minute.
Calender, or delivering-balls, make 124.1688 revols. a min.
Diameter of back roller 1⅛ inch, or 1.125 inch.
Delivering-balls 3 inches in diameter.

57.22685 revolutions of back roller a minute.
1.125 diameter of back roller.

28613425
11445370
5722685
5722685

64.38020625 divisor.

124.1688 revolutions of delivering-balls.
3 inches diam. of delivering-balls.

372.5064 dividend.

64.38)372.5064(5.786 draught at first head of drawing-frame.
32190

50606
45066

55404
51504

39000
38628

372

The draught at the first head of a drawing-frame is required from the following particulars:—
Calender, or delivering-ball, traverses 1170.2661 inches a minute.
Back roller traverses 202.2568 inches a minute.

202.2568)1170.2661(5.786 draught at first head of drawing.
10112840

15898210
14157976

17402340
16180544

12217960
12135408

82552

The draught at the first head of drawing is required from the following particulars:—

Wheel on front roller 15 teeth, working into wheel 104 teeth on shaft under rollers.
Wheel on the other end of shaft under rollers 68 teeth, working into wheel on back roller 56 teeth.
Wheel on calender, or delivering-ball-shaft, 100 teeth, driven by carrier-wheels from wheel on front roller, 38 teeth.
Diameter of back rollers $1\frac{1}{8}$ inch, or 1.125 inch.
Diameter of calender, or delivering-balls 3 inches.

```
                   100 teeth wheel on delivering-ball-shaft.
                    15 teeth wheel on front roller.
                  ----
                  1500
                    68 teeth wheel on end of shaft on the rols.
                ------
                 12000
                 9000
                ------
                102000
                 1.125 inch diameter of back rollers.
                ------
                510000
               204000
             1122000
             ---------
            114750.000 divisor.
            ----------
          38 teeth wheel on front roller, driving deliv.-ball-shaft.
         104 teeth wheel on shaft under roller.
        ----
         152
        380
        ----
        3952
          56 teeth wheel on back roller.
      ------
       23712
      19760
      ------
      221312
           3 inches, diameter of delivering-balls.
      ------
14750)663936(5.786 nearly, draught at first head of drawing-
      573750                                            frame.
     --------
       901860
       803250
       -------
        986100
        918000
        -------
         681000
         688500—nearly.
```

What length of carding will it require to supply the first head of a drawing-frame, having 2 pair of calender, or delivering-balls in front, and 6 ends of carding put up at back to each pair of calender, or delivering-balls, the back roller traversing 202.256856 inches a minute?

202.256856 or rather more than $202\frac{1}{4}$ inches.
12 ends of carding to 2 pair of balls.
2427.082272
60 minutes 1 hour.
145624.936320 inches an hour required.

If there be 8 carding-engines to a preparation, producing 1142964 inches a day, how long will it require the first head of a drawing-frame to work, to consume what the carding-engines produce, allowing the first head of drawing-frame to consume 145625 inches an hour?

145625)1142964(7.8486 hours.
1019375 60 minutes 1 hour.
1235890 50.9160, or 7 hours 51 min. nearly.
1165000
708900
582500
1264000
1165000
990000
873750
116250

N. B.—It will require the first head of a drawing-frame to work 7 hours 51 minutes successively, to consume the production of 8 carding-engines, according to the two foregoing examples.

The consumption and production of any piece of machinery will be ascertained in the same way; therefore it will not be repeated.

What weight of cotton will it require to be fed on the lap machine to produce 1142964 inches of carding a day (which is required to supply the first head of drawings), allowing 24 ounces of cotton to be fed on 30 inches of feed-cloth at the lap machine, and the draught at the carding-engine to be 127.8, and the draught at lap machine 2.115?

Multiply the draughts together, and that product by the number of inches of feed-cloth that your weight of cotton is fed on at lap machine, for a divisor, and the number of inches of carding required to supply your drawing-frame, by the weight fed on the given number of inches of feed-cloth at lap machine, for a dividend, and the quotient will be the weight in ounces required.

127.8 draught at carding-engine.
2.115 draught at lap machine.
6390
1278
1278
2556
270.2970
30 inches length of feed-cloth at lap machine.
8108.9100 divisor.

142964 inches of carding required.
24 ounces, weight fed on feed-cloth at lap machine.
4571856
2285928

8108.91)27431136(3382.8 ounces, or rather more than 211 pounds 8¾ oz. weight of cotton required to be fed on the lap machine.
2432673
3104406
2432673
6717330
6487128
2302020
1621782

6802380
6487128
315252

DRAWING-FRAME.

SECOND HEAD.

The front rollers of the different heads of a drawing-frame are generally of the same speed, and the only difference is the draught between the rollers.

If the front roller makes 326.76 revolutions a minute, the revolution of the middle roller is required, from the following particulars:—

Wheel on end of front roller, for driving-shaft under rollers, 14 teeth.
Wheel on end of shaft under rollers, 104 teeth.
Wheel on end of shaft under rollers, driving middle roller, 90 teeth.
Wheel on middle roller, 33 teeth.

104 teeth wheel on shaft under rollers.
33 teeth wheel on middle roller.

312
312

3432 divisor.

326.76 revolutions of front roller a minute.
14 teeth wheel on front roller.

130704
32676

4574.64
90 teeth wheel on shaft under rollers.

3432)411717.60(119.9643, or nearly 120 revolutions, which middle roller makes a min.
3432

6851
3432

34197
30888

33096
30888

22080
20592

14880
13728

11520
10296

1224

If the middle roller at second head of drawing makes 119.9643 revolutions a minute, what will it traverse, if the diameter be $1\frac{1}{8}$ inch?

119.9643 revolutions of middle roller a min.
1.125=$1\frac{1}{8}$ inch diameter of roller.

5998215
2399286
13196073

134.9598375
3.1416 circumference when diameter is 1.

8097590250
1349598375
5398393500
1349598375
4048795125

423.98982549000, or nearly 424 inches, the middle roller traverses a minute.

If the front roller of the second head of drawing traverses 1154.867868 inches, and the middle roller traverses 423.989825 inches per minute, what draught is there between the middle and front rollers?

423.989825)1154.867868(2.72 draught between middle and front rols.
847979650

3068882180
2967928775

1009534050
847979650

161554400

Required the draught between the middle and front rollers of the second head of drawing, from the following particulars:—

Front roller makes 326.76 revolutions a minute.
Middle roller makes 119.96 revolutions a minute.

119.96)326.76(2.72 draught between the middle and front rollers, second head of drawing.

23992

86840

83972

28680

23992

4688

The speed of back roller at second head of drawing is required, from the following particulars :—

Speed of front roller, 326.76 revolutions a minute.

Wheel on end of front roller for driving-shaft under rollers, 14 teeth.

Wheel on end of shaft under rollers, 104 teeth.

Wheel on end of shaft under rollers, driving back roller, 68 teeth.

Wheel on end of back roller, 56 teeth.

104 teeth wheel of shaft under roller.

56 teeth wheel of back roller.

624

520

5824 divisor.

326.76 revolutions of front roller a minute.

14 teeth wheel on end of front roller.

130704

32676

4574.64

68 teeth wheel on shaft under rollers.

3659712

2744784

311075.52 dividend.

```
5824)311075.52(53.412 revolutions of back roller a min.
     29120
     ─────
      19875
      17472
      ─────
       24035
       23296
       ─────
         7392
         5824
         ─────
         15680
         11648
         ─────
          4032
```

If the back roller at the second head of drawing makes 53.412 revolutions a minute, and its diameter be 1⅛ inch, what will it traverse?

```
                 53.412 revolutions of back roller a minute.
                  1.125 = 1⅛ inch diameter of do.
                 ──────
                 267060
                106824
               587532
               ────────
              60.088500
                3.1416 circumference when the diameter is 1.
              ─────────
               3605310
               600885
             2403540
             600885
           1802655
           ────────────
           188.77403160 inches, the back roller traverses a min.
```

The draught between the back and middle rollers, at the second head of drawing, is required from the following particulars:—

Middle roller traverses 424 inches a minute.

Back roller traverses 188.774 inches a minute.

188.774)424.000(2.246 draught between middle and back rols. 2d head of drawing.
377548
———
464520
377548
———
869720
755096
———
1146240
1132644
———
13596

The draught between the back and front roller is required, from the following particulars:—

Front roller traverses 1154.867868 inches a minute.
Back roller traverses 188.774 inches a minute.

188.774)1154.867868(6.117 draught between the back and front rols., 2d head of drawing.
1132644
———
222238
188774
———
334646
188774
———
1458728
1321418
———
137310

The total draught at the second head of drawing is required, from the following particulars:—

Wheel on calender or delivering-balls'-shaft, 100 teeth.
Wheel on front roller, 38 teeth.
Wheel on front roller, working shaft under front rollers, 14 teeth.
Wheel on shaft under rollers, 104 teeth.
Wheel on shaft under rollers, 68 teeth, working into a wheel on back rollers, 56 teeth.
Diameter of calender or delivering-balls, 3 inches.
Diameter of back roller, 1⅛ inch, or 1.125 inch.

Multiply the number of teeth in the driving-wheels together, respectively, and that product by the diameter of the back roller, for a divisor, and the number of teeth in the driven-wheels together, and that product by the diameter of the calender, or delivering-balls, for a dividend, and the quotient will be the real or total draught, as in the following example:—

100 teeth wheel on delivering-ball-shaft.

14 tth. wheel on front rol., driving-shaft under rollers.

1400

68 teeth wheel on shaft under rollers.

11200

8400

95200

9 or $1\frac{1}{8}$ inch diameter of back roller.

856800 divisor.

38 teeth wheel on front roller.

104 teeth wheel on shaft under rollers.

152

380

3952

56 teeth wheel on back roller.

23712

19760

221312

24 or $\frac{24}{8} = 3$ inches, diam. of deliv.-balls.

885248

442624

5311488

```
856800)5311488(6.199, or 6.2 nearly, draught between
       5140800         back roller and delivering-balls.
       -------
        1706880
         856800
        -------
         8500800
         7711200
         -------
          7896000
          7711200
          -------
           184800
```

If the third, or last head of drawing be same as the second head, what will the total draught at the three heads of drawing be, and what doubling will there be, allowing 6 ends to be put up against each pair of calender, or delivering-balls, at each head of drawing?

```
             5.786 draught at first head of drawing.
             6.199 draught at second head of drawing.
             -----
             52074
            52074
           5786
          34716
          --------
          35.867414
              6.199 draught at third head of drawing.
          ---------
          322806726
         322806726
         35867414
       215204484
       -----------
       222.342099386 rather more than 222$\frac{3}{10}$, total
                     draught at the three heads of
                     drawing.
```

DOUBLING.

6 ends of carding, first head of drawing-frame.
6 ends of drawing, second head of drawing-frame.

36
6 ends of drawing, third head of drawing-frame.

216 total doubling at drawing-frame.

N. B.—The above doubling is small, considering the quantity of doubling at many places; however, that may be arranged according to the opinion of managers, &c.

If two pairs of calender, or delivering-balls, at the first head of drawing, traverse 1120.266 inches each pair a minute; what length of drawing will they produce in 7.8476 hours, or 7 hours 51 minutes?

1120.266 in., delivering-balls traverse a min.
2 pairs at each head of drawing.

2240.532
7.8476 hours.

13443192
15683724
8962128
17924256
15683724

17582.7989232
60 minutes 1 hour.

1 ft.=12 in.)1054967.9353920 inches produced in 7.8476 hours.

1 yard=3 ft.)87913.994616 feet produced in 7.8476 hours.

29304.664872 yards produced in 7.8476 hours.

If the back roller at the second head of drawing traverses 188.774 inches a minute, and 12 ends be put up; *i. e.*, 6 ends to each pair of delivering-balls; what time must it work to consume 1054968 inches, which the first head of drawing produces?

188.774 inches, back roller traverses a minute.
12 ends, *i. e.*, 6 to each pair of deliv.-balls.

2265.288 inches consumed a minute.

2265.288)1054968.0(465.71 minutes, or 7 hours 45 minutes $42\frac{2}{5}$ seconds, the second head must work, to consume what the first head produces.

9061152

14885280
13591728

12935520
11326440

16090800
15857016

2337840
2265288

72552

If 2 pairs of delivering-balls in front of the first head of drawing, traverse 1170.266 inches each a minute; what length will they produce if they work successively 7 hours 51 minutes, or 7.8476 hours?

1170.266 inches, delivering-balls traverse a min.
2 pairs of deliv.-balls traverse in first head.

2340.532
60 minutes 1 hour.

140431.920
7.8476 hours.

84259152
98302344
56172768
112345536
98302344

1102053.535392 inches, 2 pairs of delivering-balls at first head of drawing produces in 7.8476 hours, or 7 hours 51 min.

If 12 ends be put up at the second head of drawing, that is, 6 ends to each pair of delivering-balls, and the back roller traverses 188.774 inches a minute; what time must the second head of drawing work, to consume what the first head produces, say 1102053.5 inches?

188.774 inches back roller traverses a minute.
12 ends.

2265.288 divisor.

2265.288)1102053.5(486.5 minutes nearly, or 8 hours 6½ minutes.
9061152

19593830
18122304

14715260
13591728

11235320
11326440—nearly.

It requires 8 hours 6½ minutes for the second head of drawing to work, to consume what the first head produces.

N. B.—The consumption and production of the third head of drawing will be the same as the second head.

PARTICULARS OF A DRAWING-FRAME.

First head, front roller, 326.76 revolutions a minute.
Middle roller, 128.53 revolutions a minute.
Back roller, 57.226 revolutions a minute.
Delivering-balls, 124.168 revolutions a minute.
Diameter of rollers, 1⅛ inch.
Diameter of delivering-balls, 3 inches.
Draught between back and middle rollers, 2.246.
Draught between middle and front rollers, 2.542.
Draught between front roller and delivering-balls, 1.013.
Total draught at the first head of drawing, 5.786.

Second head, front roller, 326.76 revolutions a minute.
Middle roller, 120 revolutions a minute.
Back roller, 53.412 revolutions a minute.
Delivering-balls, 124.168 revolutions a minute.
Diameter of rollers, 1⅛ inch.
Diameter of delivering-balls, 3 inches.
Draught between back and middle roller, 2.246.
Draught between middle and front roller, 2721.
Total draught at the second head of drawing, 6.123.

N. B.—The third head of drawing is the same as the second head.

First head, back roller traverses 202.256 inches a minute.
Delivering-balls traverse 1170.266 inches a minute.
Back roller consumes 1142964 inches, or 211℔s. 8¾ oz. in 7 hours 51 minutes.
Delivering-balls produce 1102053 inches, or 211℔s. 8¾ oz. in 7 hours 51 minutes.

Second and third head back rollers traverse 188.774 inches a minute.
Delivering-balls traverse 1170.266 inches a minute.
Back rollers consume 1102053 inches, or 211℔s. 8¾ oz. in 8 hours 6½ minutes.
Delivering-balls produce 1102603 inches, or 211℔s. 8¾ oz. in 8 hours 6½ minutes.

N. B.—The above weights of drawing are the gross weight of cotton; the net weight will be according to its proportionate size, or girt, in any operation, as will be shown hereafter.

TUBE-FRAME.

The tube-frame is well calculated for coarse and medium yarns.

SPEEDS, DRAUGHTS, ETC., OF THE TUBE-FRAME.

Speed of shaft for driving-frame, 143 revolutions a minute.
Diameter of drum on said shaft, 30 inches.
Diameter of pulley on frame, 9¾, or 9.75 inches.

143 revolutions of shaft a minute.
30 inches, diameter of drum on shaft.

Diam. of pulley 9.75 in.)4290.00(440 revolutions a minute of
3900 front rollers, second head.

3900
3900

N. B.—There are 2 sets or tiers of rollers to some of these frames; the back or receiving-rollers are called the first head, and the front or delivering-rollers the second head.

The speed of the middle rollers is required from the following particulars:—

Revolutions of front rollers a minute, 400.
Wheel on front rollers 21 teeth, working into stud-wheel 42 teeth.
Wheel on same stud 30 teeth, working into wheel 32 teeth on the end of middle rollers.

440 revolutions of front roller a minute.
21 teeth wheel on front roller.

440
880

9240
30 teeth wheel on stud.

277200 dividend.

42 teeth wheel on stud.
32 teeth wheel on middle roller.

84
126

1344 divisor.

1344)277200(206.25, or 206¼ revols. of mid. rols. a min.
2688
―――――
8400
8064
―――――
3360
2688
―――――
6720
6720

The speed of the back rollers is required from the following particulars:—

Revolutions of front rollers a minute, 440.

Wheel on front rollers 23 teeth, working into wheel 44 teeth on stud; on same stud there is a wheel 20 teeth, working into wheel 41 teeth on back rollers.

44 teeth wheel on stud.
41 teeth wheel on back roller.
―――――
44
176
―――――
1804 divisor.

440 revolutions of front roller a minute.
23 teeth wheel on front roller.
―――――
1320
880
―――――
10120
20 teeth wheel on stud.
―――――
202400 dividend.

1804)202400(112.195 revolutions of back roller a minute.
1804
2200
1804
3960
3608
3520
1804
17160
16236
9240
9020
220

The speed of the front rollers at the first head is required from the following particulars:—

Revolutions of back roller, second head, a minute, 112.195.

Wheel on back roller, second head 41 teeth, working into carrying-wheel 41 teeth on stud, which works into wheel 46 teeth on front roller, first head.

112.195 revols. of back rol., 2d head, a min.
41 teeth wheel on back rol., 2d head.
112195
448780

Teeth of wheel on front rols. first head, } 46)4599.995(99.9, or 100 revols. nearly, front rols. first head, a min.
414
459
414
459
414
45

The speed of the middle rollers at the first head is required from the following particulars:—

Revolutions of front rollers a minute, 100.

Wheel on front rollers 21 teeth, working into a wheel on stud 42 teeth; wheel 30 teeth on same stud, works into wheel 32 teeth on middle roller.

42 teeth wheel on stud.
32 teeth wheel on middle roller.

84
126

1344 divisor.

100 revolutions of front roller a minute.
21 teeth wheel on it.

2100
30 teeth wheel on stud.

1344)63000(46.875 revols. of mid. rol. a minute.
5376

9240
8064

11760
10752

10080
9408

6720
6720

The speed of the back roller at the first head is required from the following particulars:—

Revolutions of front rollers a minute, 100.

Wheel on front rollers 27 teeth, working into stud wheel 58 teeth; on same stud there is a wheel 17 teeth, working into wheel 58 teeth on back rollers.

58 teeth wheel on stud.
58 teeth wheel on back rollers.

464
290

3364 divisor.

100 revolutions of front rollers a minute.
27 teeth wheel on front rollers.

2700
17 teeth in wheel on stud.

18900
2700

3364)45900(13.644 revolutions of back roller a minute.
3364

12260
10092

21680
20184

14960
13456

15040
13456

1584

N. B.—When working the speeds of rollers, the driven-wheels multiplied into each other will be the divisor.

The speed of the friction rollers is required from the following particulars:—

Revolutions of front rollers, second head, a minute, 440.

Wheel on front rollers 28 teeth, working into wheel 59 teeth on bevil-shaft; on the other end of bevil-shaft there is a wheel 32 teeth, working into wheel 50 teeth on friction-roller-shaft.

59 teeth wheel on bevil-shaft.
50 teeth wheel on friction-roller-shaft.

2950 divisor.

440 revolutions of front rollers a minute.
28 teeth wheel on front rollers.

3520
880

12320
32 teeth wheel on bevil-shaft.

24640
36960

2950)394240(133.64 revolutions of friction-rols. a minute.
2950

9924
8850

10740
8850

18900
17700

12000
11800

200

The speed of the tubes is required from the following particulars:—

Revolutions of pulley-shaft a minute, 440.
Diameter of pulley on said shaft, 18 inches.
Diameter of tubes, $\frac{7}{8}$ inch, or .875 inch.

440 revolutions of pulley-shaft a min.
18 inches, diam. of pul. on said shaft.

3520
440

7920

Inches diam. of tubes .875)7920(9051.428 revols. of tubes a min.
7875

4500
4375

1250
875

3750
3500

2500
1750

7500
7000

500

The draught between the back and middle rollers at the first head is required from the following particulars:—

Revolutions of back rollers a minute, 13.644.
Revolutions of middle rollers a minute, 46.875.
Diameters of back and middle rollers, 1 inch.

13.644)46.875(3.435 draught between back and middle rollers.
40932

59430
54576

48540
40932

76080
68220

7860

The draught between the middle and front rollers is required from the following particulars:—

Revolutions of middle rollers a minute, 46.875.
Revolutions of front rollers a minute, 100.

Diameter of middle rollers, 1 inch.
Diameter of front rollers, $1\frac{1}{8}$ inch, or 1.125 inch.
100 revolutions of front rollers a minute.
1.125 inch diameter of do.

46.875)112.500(2.4 draught between middle and front rols.
93750

187500
187500

The total draught at the first head is required from the following particulars:—

Draught between back and middle rollers, 3.435.
Draught between middle and front rollers, 2.4.

3.435
2.4

13740
6870

8.2440 nearly $8\frac{1}{4}$ total draught, first head.

The draught between the front roller first head, and the back roller second head, is required from the following particulars:—

Revolutions of front rollers first head a minute, 100.
Revolutions of back rollers second head a minute, 112.195.
Diameter of front rollers first head, $1\frac{1}{8}$ inch, or 1.125 inch.
Diameter of back rollers second head, 1 inch.

100 revols. of front roller a min. first head.
1.125 inches diameter of front roller.

112.500 divisor.

112.5)112.195(0.997 diminution of draught between the two heads of rollers.
10125

10945
10125

8200
7875

325

N. B.—On account of the distance between the first and second head of rollers, a draught would be injurious.

The draught between the back and middle rollers at the second head is required from the following particulars:—

Revolutions of back rollers a minute, 112.195.
Revolutions of middle rollers a minute, 206.25.
Diameters of middle and back rollers, 1 inch.

112.195)206.250(1.8383 draught between back and middle rollers second head.
112195
940550
897560
429900
336585
933150
897560
355900
336585
19315

The draught between the middle and front rollers at the second head is required from the following particulars:—

Revolutions of middle rollers a minute, 206.25.
Revolutions of front rollers a minute, 440.
Diameter of middle roller, 1 inch.
Diameter of front roller, 1⅛ inch, or 1.125 inch.

1.125 inch, diameter of front rollers.
440 revolutions of front rollers a minute.
45000
4500

206.25)495000(2.4 draught between mid. and front rols.
41250
82500
82500

The draught between the front rollers and friction-rollers is required from the following particulars:—

Revolutions of front rollers a minute, 440.
Revolutions of friction-rollers a minute, 133.64.
Diameter of friction-rollers, 4 inches.
Diameter of front rollers, $1\frac{1}{8}$ inch, or 1.125 inch.

440 revolutions of front rollers.
1.125 inches diameter of front rollers.

45000
4500

495.000 divisor.

133.64 revolutions of friction-rollers.
4 inches diameter of friction-rollers.

495)534.56(1.08 nearly, draught between front rollers and friction-rollers.
495

3956
3960—nearly.

The total draught at the second head is required from the following particulars: (including draught between front rollers and friction-rollers.)

Draught between back and middle rollers, 1.8383.
Draught between middle and front rollers, 2.4.
Draught between front and friction-rollers, 1.08.

1.8383 draught between back and middle rollers.
2.4 draught between middle and front rols.

73532
36766

4.41192 draught between back and front rollers.
1.08 draught between front and friction-rols.

3529536
4411920

4.7648736 total draught between back rollers second head, and friction-rollers.

The total draught at a tube-frame is required from the following particulars:—

Draught at first head, 8.244
Draught at second head, and friction-rollers, 4.764

32976
49464
57708
32976

39.274416 total draught.

The total draught at a tube-frame is required from the following particulars:—

Wheel on friction-roller-shaft 50 teeth, working into
Wheel on bevil-shaft 32 teeth.
Wheel on top of shaft 59 teeth, working into
Wheel on front roller second head 28 teeth.
Wheel on front roller second head 23 teeth, working into
Wheel on stud 44 teeth.
Wheel on same stud 20 teeth, working into
Wheel on back roller second head 41 teeth, working into a
Wheel on stud 41 teeth, which works into
Wheel on front roller first head 46 teeth.
Wheel on front roller 27 teeth, working into
Wheel on stud 58 teeth.
Wheel on same stud 17 teeth, working into
Wheel on back roller first head 58 teeth.
Diameter of friction-pulley, 4 inches.
Diameter of back roller first head, 1 inch.

50 teeth wheel on friction-roller-shaft.
59 teeth wheel on top of bevil-shaft.

2950
23 teeth wheel on front roller second head.

8850
5900

67850
20 teeth wheel on second head.

1357000

1357000
41 teeth wheel on stud between the heads.

1357000
5428000

55637000
27 teeth wheel on front roller first head.

389459000
111274000

1502199000
17 teeth wheel on stud first head.

10515393000
1502199000

25537383000 divisor.

32 teeth wheel on bevil-shaft.
28 teeth wheel on front roller second head.

256
64

896
44 teeth wheel on stud second head.

3584
3584

39424
41 teeth wheel on back roller.

39424
157696

1616384
46 teeth wheel on front roller.

9698304
6465536

74353664

74353664
58 teeth wheel on stud.

594829312
371768320

4312512512
58 teeth wheel on back roller first head.

34500100096
21562562560

250125725696
4 inches diameter of friction-pulley.

25537383.000)1000502902.784(39.178 total draught between back rols. first head and friction-rols.
76612149

234381412
229836447

45449657
25537383

199122748
178761681

203610674
204299064—nearly.

N. B.—The small difference between this and the other method arises from the decimal parts; however, the last method is the most accurate.

If the back rollers at the first head make 13.644 revolutions a minute, and their diameter be 1 inch; what will they traverse?

13.644
3.1416 circumference when the diam. is 1.

81864
13644
54576
13644
40932

42.8639904 nearly 43 inches, back rollers traverse at first head a minute.

If 22 drawings be put up at the back of the tube-frame, what length will it consume a minute, if the back rollers traverse 42.864 inches a minute?

42.864 inches back rollers traverse a minute.
22 drawings put up at the back of the frame.

85728
85728

943.008 inches of drawing consumed a minute.

What time must a tube-frame work to consume 551027 inches of drawing, if it consumes 943 inches a minute?

943)551027(584 minutes, or 9 hours, 44 minutes tube-frame must work successively, to consume what the last head of drawing produces.
4715

7952
7544

4087
3772

315

N. B.—There are 1102054 *inches of drawing produced at the last head of drawings; but on account of the drawing being put up double at the back of the frame, only one-half the length is reckoned for consumption, i. e.* 551027 *inches.*

If the front roller of a tube-frame makes 440 revolutions a minute, and the diameter of the rollers be $1\frac{1}{8}$ inch; what length of roving will the frame produce, if it contains 22 tubes, and works 9 hours, 44 minutes successively in 1 day?

1.125 diameter of front rollers = $1\frac{1}{8}$ inch.
3.1416 circumference when the diameter is 1.

6750
1125
4500
1125
3375

35.343000
440 revolutions of front rollers a minute.

1413720
141372

1555.0920 inches, each tube receives a minute.
22 drawings put up at back of the frame.

3110184
3110184

34212.024 inches, or 950 yards, 12 inches, or 1 hank 110 yards, 12 inches, tube-frame produces a minute, *i. e.*, if there be no draught betwixt the front rollers and the friction-rollers.

34212 inches of roving produced a minute.
584 minutes = 9 hours, 44 minutes.

136848
273696
171060

1 yd. = 36 in. { 6)19979808 inches of roving produced.
6)3329968

554994.66

Yards in a hank, 840)554994.66(660.7 hanks, or 660 hanks, 4 leas, 114 yards.
5040
5099
5040
5946
5880
66

If 660 hanks of roving weighs 211½lbs. what hank roving will it be?

211.5)660.7(3.124, or 3⅛ hank roving nearly.
6345
2620
2115
5050
4230
8200
8460—nearly.

N. B.—If the 211½lbs. of cotton had been carried through all the different processes of carding, drawing, and roving, without any loss, it would have produced a roving equal to 3.124 *hanks to the pound, but as loss is sustained in the different processes, that loss can only be accurately ascertained by working the weight of cotton consumed regularly through all the processes, and ascertaining the net weight of roving which will be according to the following example.*

If the roving be 3.75 hanks to the pound; what will be the net weight of 660.7 hanks, and what weight will be lost at the different processes, allowing 211½lbs. to have been consumed at the carding-engines?

Hank roving, 3.75)660.7(176.186lbs. weight of roving produced from 211½lbs. of cotton.
375
―――
2857
2625
―――
2320
2250
―――
700
375
―――
3250
3000
―――
2500
2250
―――
250

211.5lbs. of cotton consumed at 1 prep. a day.
176.186lbs. of roving produced at 1 prep. a day.
―――
35.314lbs. loss sustained in working through the different processes, which is nearly 2½ ounces to the pound.

If a tube-frame produces 176.186lbs. of roving a day; what weight of roving will it produce in 6 days?

176.186lbs. of roving produced a day.
6 days
―――
1057.116lbs., or 1057lbs. 1¾ oz. a week.
16 oz. = 1lb.
―――
696
116
―――
1.856 oz.
4 qrs. = 1 oz.
―――
3.424 qrs.

PARTICULARS OF A TUBE-FRAME.

Revolutions of friction-rollers a minute, 133.64.
Revolutions of front rollers second head a minute, 440.
Revolutions of middle rollers second head a minute, 206.25.
Revolutions of back rollers second head a minute, 112.195.
Revolutions of front rollers first head a minute, 100.
Revolutions of middle rollers first head a minute, 46.875.
Revolutions of back rollers first head a minute, 13.644.
Revolutions of tubes a minute, 9051.428.
Diameter of friction-rollers, 4 inches.
Diameter of tubes, $\frac{7}{8}$ inch.
Diameter of front rollers first and second head, $1\frac{1}{8}$ inch.
Diameter of middle and back rollers first and second head, 1 inch.
Tube traverses a minute, 24881 inches.
Friction-rollers traverse a minute, 1679 inches.
Front rollers second head traverse a minute, 1555 inches.
Middle rollers second head traverse a minute, 648 inches.
Back rollers second head traverse a minute, 352.5 inches.
Front rollers first head traverse a minute, 353.4 inches.
Middle rollers first head traverse a minute, 147.24 inches.
Back rollers first head traverse a minute, 42.85 inches.

DRAUGHTS.

Draught between back and middle rollers first head, 3.435.
Draught between middle and front rollers first head, 2.4.
Draught between front rollers first head and back rollers second head, 0.997.
Draught between back and middle rollers second head, 1.8383.
Draught between middle and front rollers second head, 2.4.
Draught between front rollers and friction-rollers, 1.08.
Total draught at the first head, 8.244.
Total draught at the second head, 4.4119.
Total draught at tube-frame, 39.178.

N. B.—The consumption and production is according to the traversing of the rollers, which in all cases will be found by multiplying the number of revolutions of the rollers by their circumferences.

The distance of the rollers from each other must be regulated according to the staple and quality of cotton.

SLABBING-FRAME.

The speed of the principal, or main-shaft at slabbing-frame, is required from the following particulars?

Revolutions of shaft a minute driving slabbing-frame, 114.

Diameter of drum on said shaft, 16 inches.

Diameter of pulley on frame-shaft, 15 inches.

```
                                  114 revols. of driving-shaft a minute.
                                   16 diameter of drum on driving-shaft.
                                  ---
                                  684
                                 114
                                 ----
Diam. of pulley, 15 in.)1824(121.6 revols. of frame-shaft a min.
                        15
                        --
                         32
                         30
                         --
                          24
                          15
                          --
                           90
                           90
```

The speed of the front rollers is required from the following particulars:—

Revolutions of frame-shaft a minute, 121.6.

Wheel on said shaft 64 teeth, working into carrying-wheel 138 teeth on stud, which works into a wheel 60 teeth on front rollers.

```
                                   121.6 revols. of frame-shaft a min.
                                      64 teeth wheel on said shaft.
                                    ----
                                    4864
                                   7296
                                   ------
Wheel on front roller, 60 tth.)7782.4
                               ------
                              129.706 revols. of front rols. a min.
```

The speed of the middle rollers is required from the following particulars:—

Revolutions of front rollers a minute, 129.7.

Wheel on front rollers 24 teeth, working into wheel 70 teeth on stud; on the same stud a wheel 25 teeth works into wheel 56 teeth on back rollers; wheel on the other end of back rollers 30 teeth, working into wheel 64 teeth on stud, which works into wheel 27 teeth on middle rollers.

129.7 revolutions of front rollers a minute.
24 teeth wheel on front rollers.

5188
2594

3112.8
25 teeth wheel on stud. (Change pinion.)

155640
62256

77820.0
30 teeth wheel on back roller.

2334600 dividend.

70 teeth wheel on stud.
56 teeth wheel on back rollers.

3920
27 teeth wheel on middle roller.

27440
7840

105840 divisor.

105840)2334600(22.0578 revols. of middle rols. a min.
211680

217800
211680

612000
529200

828000
740880

871200
846720

24480

The speed of the back rollers is required from the following particulars:—

Revolutions of front rollers a minute, 129.7.

Wheel on front rollers 24 teeth, working into wheel 70 teeth on stud; wheel 25 teeth on same stud, works into wheel 56 teeth on back rollers.

129.7 revolutions of front rollers a min.
24 teeth wheel on front rollers.

5188
2594

3112.8
25 teeth wheel on stud.

155640
62256

77820.0 dividend.

70 teeth wheel on stud.
56 teeth wheel on back rollers.

3920 divisor.

3920)77820(19.852 revolutions of back rols. a minute.
3920

38620
35280

33400
31360

20400
19600

8000
7840

160

The traversing of the front, middle, and back rollers, are required from the three foregoing examples, allowing the front rollers to be 1⅛ inch, and the middle and back rollers 1 inch diameter.

129.7 revolutions of front rollers a minute.
1.125 inches, diameter of front rollers.

6485
2594
1297
1297

145.9125
3.1416 circumference when diameter is 1.

8754750
1459125
5836500
1459125
4377375

458.39871000 inches, front roller traverses a min.

22.0578 revolutions of middle rollers a minute.
3.1416 circumference when the diameter is 1.

1323468
220578
882312
220578
661734

69.29678448 inches, middle rollers traverse a min.

19.852 revolutions of back rollers a min.
3.1416 circum. when the diameter is 1.

119112
19852
79408
19852
59556

62.3670432 inches, back rollers traverse a min.

The draught between the back and middle rollers, the draught between the middle and front rollers, and the total draught is required from the three foregoing examples?

62.367)69.29678(1.111, or rather more than 1$\frac{1}{9}$ draught
62367 between back and middle rollers.
69297
62367
69308
62367
69410
62367
7043

69.2967)458.39870(6.615 draught between middle and front
4157802 rollers.
4261850
4157802
1040480
692967
3475130
3464835
10295

62.367)458.3987(7.35 draught between back and front rols.,
436569 or total draught at slabbing-frame.
218297
187101
311960
311835
125

The draught between the back and middle rollers is required from the following particulars :—

Wheel on back rollers 30 teeth, working into wheel 64 teeth on stud, which works into wheel 27 teeth on middle roller.

Diameter of back and middle rollers, each 1 inch.

$$\text{Teeth of wheel on middle roller, 27}\left\{\begin{array}{l}3)30\ \text{teeth wheel on back rollers.}\\ \hline 9)10\\ \hline 1\frac{1}{9}\ \text{draught between back and middle rollers.}\end{array}\right.$$

The draught between the middle and front rollers is required from the following particulars:—

Wheel on front roller 24 teeth, working into wheel 70 teeth on stud; wheel 25 teeth on same stud, working into wheel 56 teeth on back rollers; on the other end of back rollers, wheel 30 teeth working into wheel 64 teeth on stud; same stud wheel working wheel 27 teeth on middle rollers.

Diameter of front rollers, 1$\frac{1}{8}$, or 1.125 inch.
Diameter of back rollers, 1 inch.

DRIVING-WHEELS.

24 teeth wheel on front rollers.
25 teeth wheel on stud working back rols.

120
48

600
30 teeth wheel on back rollers.

18000
8, or 1 inch diameter of middle rollers.

44000 divisor.

DRIVEN-WHEELS.

70 teeth wheel on stud.
56 teeth wheel on back rollers.

3920

3920
27 teeth wheel on middle rollers.

27440
7840

105840
9, or $\frac{1}{9}$ inch diameter of middle rollers.

144000)952560(6.615 draught between middle and front rollers.
864000

885600
864000

216000
144000

720000
720000

The total draught is required from the following particulars:—
Wheel on front rollers 24 teeth, working into wheel 70 teeth on stud; wheel on same stud 25 teeth, working into wheel 56 teeth on back rollers.
Diameter of back rollers, 1 inch.
Diameter of front rollers, $1\frac{1}{8}$, or 1.125 inch.

DRIVING-WHEELS.

24 teeth wheel on front rollers.
25 teeth wheel on stud. (Change pinion.)

120
48

600
8, or 1 inch diameter of back rollers.

4800 divisor.

DRIVEN-WHEELS.
70 teeth wheel on stud.
56 teeth wheel on back rollers.

3920
9, or $1\frac{1}{8}$ inch diameter of front rollers.

48.00 { 12)352.80
4) 29.4

7.35 total draught at slabbing-frame.

What length of drawing will be required to supply a slabbing-frame 1 day (allowing it to work at the rate of 9 hours successively), having 40 spindles, and the back rollers traversing 62.367 inches a minute?

62.367 inches, back rollers traverse a min.
40 spindles in frame.

2494.680
9 hours = 1 day.

22452.120
60 minutes = 1 hour.

36 in., 1 yard, { 6)1347127.200 inches of drawing required a day.
6)224521.2

37420.2 yards of drawing, or 44 hanks, 3 leas, $110\frac{1}{5}$ yards, required to supply a slabbing-frame 9 hours, or 1 day.

What time must a slabbing-frame with 40 spindles work a day, to consume 1102054 inches of drawing, if it consumes 2494.68 inches a minute?

2494.68)1102054(441.76 minutes or 7 hours, 21 minutes, 45 seconds, the slabbing-frame must work to consume what the last head of drawings produces.
997872
1041820
997872
439480
249468
1900120
1746276
1538440
1496808
41632

If the front rollers of a slabbing-frame traverse 458.4 inches a minute, and the diameter of the rollers be $1\frac{1}{8}$ inch, the number of spindles 40; what length of slabbing will it produce in 7 hours, 21 minutes, and 45 seconds, or 441.76 minutes?

458.4 inches, rollers traverse a minute.
40 spindles in frame.
18336.0 slabbing-frame produces a minute.
441.76 minutes, or 7 hours, $21\frac{3}{4}$ minutes.
110016
128352
18336
73344
73344

1 yd.=36in. { 6)8100111.36 inches of slabbing produced in 7 hours $21\frac{3}{4}$ minutes.
6)1350018.56

1 lea = 120 yds.)225003.0933 yards of slabbing produced in 7 hours, $21\frac{3}{4}$ minutes.
1 hank = 7 leas)1875.02577 leas of slabbing produced in 7 hours, $21\frac{3}{4}$ minutes.
267.860822

267.860822 hanks of slabbing produced in 7
7 leas, 1 hank. [hours, 21¾ minutes.

6.025755 leas.
120 yards, 1 lea.

3.090666 yds. or 267 hanks, 6 leas, 3 yds.

If 267 hanks, 6 leas, and 3 yards, or 267.8608 hanks of slabbing weighs 211½℔s.; what hank will it be?

RULE—Divide the number of hanks by the weight, and the quotient will be the hanks in one pound.

℔s. Hanks.
211.5)267.8608(1.266 hanks of slabbing in one pound.
2115

5636
4230

14060
12690

13708
12690

1018

If the 211½ ℔s. of cotton had been carried through the different operations without waste, according to the foregoing doublings and draughts, it would have produced a slabbing equal to 1.266, or rather more than 1¼ hanks to the pound, but on trying the slabbing I find it to be equal to 1.5 hanks to the pound: what loss is sustained in working?

RULE—Divide the number of hanks produced by the hank-slabbing, which, subtracted from the gross weight of cotton, say 211½℔s., will show the loss sustained in working.

```
                         Hanks
Hank-slabbing, 1.5)267.8608(178.574, or 178℔s. 9 oz. of slab-
                   15             bing produced from 211½℔s.
                   ——             of cotton.
                   117
                   105
                   ———
                    128
                    120
                    ———
                      86
                      75
                     ———
                     110
                     105
                     ———
                       58
                       60—nearly.
```

℔s.	oz.	
211	8	gross weight of cotton fed on lap machine.
178	9	net weight of slabbing produced.
32	15	loss sustained in working. (Flies, strips, &c.)

TURNS AN INCH ON SLABBING.

The turns an inch on the slabbing, are required from the following particulars:—

Revolutions of frame-shaft a minute, 121.6.

Wheel on said shaft 90 teeth, working into wheel 138 teeth on stud, which works into wheel 46 teeth on shaft for driving spindles.

Wheel on shaft driving spindles, 50 teeth.

Wheel on spindles, 25 teeth.

Front rollers traverse 458.3987, or nearly 458.4 inches a minute.

N. B.—The wheel 138 *teeth is a carrying-wheel; there is another wheel* 138 *teeth which is omitted, it being a carrier also.*

121.6 revolutions of frame-shaft a minute.
90 teeth in wheel on said shaft.

10944.0
50 teeth wheel on spindle-shaft.

547200 dividend.

46 teeth wheel (driven) on spindle-shaft.
25 teeth wheel on spindles.

230
92

1150 divisor.

1150)547200(475.8 revolutions of spindles a minute.
4600

8720
8050

6700
5750

9500
9200

300

Inches. Revolutions of spindles.
458.3987)475.8260(1.038 turns an inch on slabbing.
4583987

17427300
13751961

36753390
36671896

81494

ROVING-FRAME.

The speed of the first propelled-shaft of the roving-frame is required from the following particulars:—

Revolutions of shaft driving roving-frame a minute, 143.
Diameter of drum on said shaft, 16 inches.
Diameter of pulley on frame-shaft, 15 inches.

143 revolutions of shaft a minute.
16 inches diameter of drum on shaft.
858
143
Inches diam. of pulley, 15, 5)2288
3)457.6
152.533 revolutions of first propelled-shaft at roving-frame a minute.

The speed of the front rollers is required from the following particulars:—

Revolutions of frame-shaft a minute, 152.533.
Wheel on same shaft 54 teeth, working into carrying-wheel 138 teeth, which works into wheel 70 teeth on front rollers.

152.533 revols. of shaft a minute.
54 teeth wheel on said shaft.
610133
762666
Teeth of wheel on front rols., 70)8236.800
117.66857 revols. of front rollers a min.

If the front rollers of a roving-frame make 117.66857 revolutions a minute, and their diameter be 1⅛, or 1.125 inch; what will they traverse a minute?

117.6685 revols. of front rollers a minute.
1.125, or 1⅛ inch diameter of front rol.
5883425
2353370
1176685
1176685
132.3770625

132.3770625
3.1416 circumference when diameter is 1.

7942623750
1323770625
5295082500
1323770625
3971311875

415.87577955000 inches, front rol. traverses a min.

The speed of the middle rollers is required from the following particulars:—

Revolutions of front rollers a minute, 117.6685.
Wheel on front rollers 24 teeth, working into wheel 70 teeth on stud; on same stud wheel 24 teeth, works into wheel 60 teeth on back rollers; wheel 30 teeth on the other end of back rollers, works into wheel 64 teeth on stud, which works into wheel 24 teeth on middle rollers.

117.6685 revols. of front rols. a min.
24 teeth wheel on do.

4706740
2353370

2824.0440
24 teeth wheel on stud.

11296176
5648088

67777.056
30 teeth wheel on back rollers.

2033311.680 dividend.

70 teeth wheel on stud.
60 teeth wheel on back rollers.

4200
24 teeth wheel on middle rollers.

16800
8400

100800 divisor.

1008.00)20333.11.68(20.1717 revols. of mid. rols. a minute.
2016

1731
1008

7231
7056

1756
1008

7488
7056

432

If the middle rollers be 1 inch diameter, making 20.1717 revolutions a minute; what will they traverse?

20.1717 revolutions of middle rollers a minute.
3.1416 circumference when diameter is 1.

1210302
201717
806868
201717
605151

63.37141272 inches, middle rollers trav. a minute.

The speed of the back rollers is required from the following particulars:—

Revolutions of front rollers a minute, 117.6685.

Wheel on front rollers 24 teeth, working into wheel 70 teeth on stud; on same stud wheel 24 teeth, works into wheel 60 teeth on back rollers.

117.6685 revolutions of front rollers a minute.
24 teeth wheel on do.

4706740
2353370

2824.0440

2824.0440
24 teeth wheel on stud.

11296176
5648088

67777.056 dividend.

70 teeth wheel on stud.
60 teeth wheel on back rollers.

4200 divisor.

42.00)677.77.056(16.137 revolutions of back rollers a minute.
42

257
252

57
42

157
126

310
294

16

If the back rollers be 1 inch diameter, making 16.137 revolutions a minute; what will they traverse?

16.137 revolutions of back rollers a minute.
3.1416 circumference when diameter is 1.

96822
16137
64548
16137
48411

50.6959992, or $50\frac{7}{10}$ inches nearly, back rollers traverse a minute.

The draught of roving-frame is required from the following particulars:—

Wheel on front rollers, 24 teeth (driving).
Wheel on stud, 70 teeth (driven).
Wheel on same stud, 24 teeth (driving).
Wheel on back rollers, 60 teeth (driven).
Diameter of back rollers, 1 inch (driving).
Diameter of front rollers, $1\frac{1}{8}$ inch (driven).

DRIVING-WHEELS.

24 teeth wheel on front rollers.
24 teeth wheel on stud. (Change pinion.)

96
48

576
8=1 inch, diameter of back rollers.

4608 divisor.

DRIVEN-WHEELS.

70 teeth wheel on stud.
60 teeth wheel on back rollers.

4200
9, or $1\frac{1}{8}$ inch, diameter of back rollers.

37800 dividend.

4608)37800(8.203
36864

9360
9216

14400
13824

576

If the back rollers of a roving-frame traverse 50.696 inches a minute, with 72 spindles; what length of slabbing will it consume, allowing the slabbing to be doubled, or 2 ends to each spindle?

50.696 inches, back rollers traverse a minute.
72 spindles in frame.
101392
354872
3650.112
2 slabbings to each spindle.
7300.224 inches, of slabbing consumed at roving-frame a minute.

If 1 roving-frame consumes 7300.224 inches of slabbing a minute; what time must 2 roving-frames work, to consume 8100111.36 inches?

7300.224 inches, consumed a min. by 1 frame.
2 frames.
Divisor, 14600.448 inches, 2 frames consume a minute.

14600.448)8100111.36(554.78 minutes, or 9 hours, 14¾ minutes, 2 roving-frames must work successively, to consume what the slabbing-frame produces.
73002240
79988736
73002240
69864960
58401792
114631680
102203136
124285440
116803584
7481856

What length of roving will 2 frames, of 72 spindles each, produce in 9 hours, 14¾ minutes, or 554.78 minutes, if the front rollers traverse 415.87 inches a minute?

415.87 inches front rollers traverse a minute.
72 spindles in 1 frame.
83174
291109
29942.64 inches of roving one frame produced a [minute.
2 frames.
59885.28 inches of roving 2 frames prod. a min.
554.78 minutes, or 9 hours, 14¾ minutes.
47908224
41919696
23954112
29942640
29942640
33223155.6384 inches of roving the 2 frames produce in 554.78 minutes, or 9 hours 14¾ min.

How many hanks of roving are there in 33223155.6384 inches?

1 yard is 36 in. { 6)33223155.6384 inches of roving.
6)5537192.6064

1 hank is 840 yards,)922865.4344(1098.6493 hanks of roving.
840
8286
7560
7265
6720
5454
5040
4143
3360
7834
7560
2744
2520
224

7 leas 1 hank.
4.5451 leas.
120 yards 1 lea.
65.4120 yards.

33223155.6384 inches of roving will be 1098.6493 hanks, or 1098 hanks, 4 leas, and 65 yards.

If 1098 hanks, 4 leas, and 65 yards, or 1098.6493 hanks of roving weigh 211½ pounds; what hank will it be?

Pounds. Hanks.
211.5)1098.6493(5.194 hanks roving.
10575
4114
2115
19999
19035
9643
8460
1183

N. B.—If the 211½*lbs. of cotton could be carried through all the different operations in the card room to the roving without waste, it would produce a roving equal to* 5.194 *hanks in the pound (allowing the doublings and draughts to be the same, as shown in former examples).*

If, on trying the roving, its weight is equal to 6.15 hanks in the pound, what weight of roving will there be in 1098.649 hanks?

Hanks. Hanks yarn.
6.15)1098.649(178.64 pounds of roving.
615 16 oz. 1 pound.
4836 384
4305 64
5314 10.24 oz.
4920
3949
3690
2590
2460
130

Weight of cotton fed on lap machine,	211lbs.	8 oz.
Weight of roving produced, - - -	178lbs.	10¼ oz.
Loss sustained in working, - - -	32lbs.	13¾ oz.

The speed of the spindles of roving-frame is required from the following particulars:—

Revolutions of frame-shaft a minute, 152.533.

Wheel on frame-shaft 68 teeth, working into carrying-wheel 138 teeth, which works into a wheel 52 teeth on spindle-shaft; wheel 72 teeth on spindle-shaft, works into wheel 18 teeth on spindle.

152.533 revolutions of frame-shaft a minute.
68 teeth wheel on frame-shaft.

1220266
915200

10372.266
72 teeth wheel on spindle-shaft for driving spindles.

20744533
72605866

746803.200 dividend.

52 teeth wheel on spindle-shaft.
18 teeth wheel on spindle.

416
52

936 divisor.

936)746803.2(797.86 revolutions of roving-frame spindles a minute.
6552

9160
8424

7363
6552

8112
7488

6240
5616

624

The turns an inch of roving are required, from the following particulars:—

Revolutions of spindles a minute, 797.86.
Front rollers traverse a minute, 316 inches.

316)797.86(2.525 turns an inch of roving.
632
1658
1580
786
632
1540
1580—nearly.

The speeds of any moving power belonging to machinery may be found in the same manner as illustrated in the foregoing examples.

The construction of the slabbing and roving-frames differs materially; every machine-maker having a method of his own, whereby to work the different moving powers, belonging to, and connected with, the slabbing and roving-frames; while every master, manager, and overlooker generally gives a preference to some particular machine-maker.

Improvements in all kinds of machinery are continually progressing, but the system of calculations remains the same; therefore the system being well grounded, and on sure *data*, the improvements possible to be made will be the more easily arrived at, and while theory and practice are combined together, it will give both pleasure and satisfaction to the mind.

THROSTLE-FRAME.

THROSTLES, like all other machinery, vary in construction either in one part or another, and while some persons prefer the patent throstles, of which there are several, others give the preference to the common throstle; but whatever the construction of the machine may be, any person having a thorough knowledge of calculations in addition to practice, will be enabled to form a proper estimate of machinery according to improvements and alterations made.

To produce regular yarns, it is very essential to have good washers; in place of round pieces of cloth, many prefer a strip of stout washer cloth, of a proper width, and length of the throstle, with holes, according to the number and distance of spindles. The washers, being stationary, have more power on the bobbins; consequently, the yarns receive the twist more regularly.

The speed of the tin drum, or cylinder for driving spindles, is required from the following particulars:—

Revolutions of shaft for driving throstles a minute, 153.
Diameter of drum on said shaft, 24 inches.
Diameter of pulley on tin drum, or cylinder-shaft for driving spindles, 10 inches.

153 revolutions of shaft a minute.
24 inches, diam. of drum on shaft.

612
306

Diam. of pulley, 10 in.)3672

367.2, or 367$\frac{1}{5}$ revolutions of tin drum, or cylinder for driving spindles, a minute.

If the tin drum, or cylinder for driving spindles, makes 367.2 revolutions a minute; what number of revolutions will the spindles make, if the tin drum, or cylinder, be 12 inches diameter, and the wharves 1 inch.

367.2 revols. of tin drum, or cylinder, a min.
12 inches, diameter of tin drum.

4406.4 revolutions of spindles a minute.

The revolutions a minute of the front rollers are required from the following particulars:—

Revolutions of pulley-shaft a minute, 367.2.
Wheel on same shaft 32 teeth, working into large stud wheel 122 teeth; on same stud a wheel 40 teeth, works into carrying-wheel 122 teeth, which works into wheel 54 teeth on front rollers.

367.2 revolutions of pulley-shaft a minute.
32 teeth wheel on shaft.

7344
11016

11750.4
40 teeth wheel on stud.

470016.0 dividend.

122 teeth wheel on stud.
54 teeth wheel on end of front rollers.

488
610

6588 divisor.

6588)470016(71.344 revols. of front rols. a min.
46116

8856
6588

22680
19764

29160
26352

28080
26352

1728

If the front rollers of a throstle make 71.344 revolutions a minute; what will they traverse if they be 1 inch diameter?

71.344 revolutions of front rollers a min.
3.1416 circumference when diameter is 1.

428064
71344
285376
71344
214032

224.1343104 rather more than 224$\frac{1}{8}$ inches, front rollers traverse a minute.

If the front rollers of a throstle traverse, or deliver 224.134 inches a minute; how many hanks a spindle will be produced in 1 week, if the throstle works successively 60 hours, thus allowing 9 hours for doffing and other stoppages?

224.134 inches, front rollers deliver a min.
60 minutes, 1 hour.

13448.040
60 hours, 1 week.

36 inches, 1 yd. { 6)806882.400 inches produced a spindle a week.
6)134480.4

1 lea is 12.0 yds.)2241.3.4 yards produced a week.

1 hank is 7 leas,)186.77833 leas produced a week.

26.682619 hanks produced a week.
7 leas 1 hank.

4.778333 leas.
120 yards 1 lea.

93.340000 yards.

The length produced a spindle in 60 hours, or 1 week, will be 26 hanks, 4 leas, and 93$\frac{4}{10}$ yards.

The speed of the middle rollers is required from the following particulars:—

Revolutions of front rollers a minute, 71.344.

Wheel on front rollers 20 teeth, working into stud wheel 90 teeth; on the same stud change wheel 23 teeth, works into wheel 46 teeth on back rollers; on the other end of back rollers there is a wheel 25 teeth, working into carrying-wheel 36 teeth on stud, which works into wheel 19 teeth on middle rollers.

```
         71.344 revolutions of front rollers a minute.
             20 teeth wheel on front roller.
       --------
       1426.880
             23 teeth wheel.   (Change pinion.)
       --------
        4280640
       2853760
       --------
      32818.240
           25 teeth wheel on back rollers.
      --------
     16409120
     6563648
    ---------
    820456.00 dividend.

                 90 teeth wheel on stud.
                 46 teeth wheel on back rollers.
                ---
               4140
                 19 teeth wheel on middle rollers.
              -----
              37260
              4140
              -----
              78660 divisor.

78660)820456(10.43 revolutions of middle rollers a minute.
      78660
      -----
       338560
       314640
       ------
        239200
        235980
        ------
          3220
```

If the middle rollers of a throstle be $\frac{3}{4}$ inch diameter, making 10.43 revolutions a minute; what will they traverse?

10.43 revolutions of middle rollers a minute.
.75, or $\frac{3}{4}$ inch diameter of middle rollers.

5215
7301

7.8225
3.1416 circumference when diameter is 1.

469350
78225
312900
78225
234675

24.57516600 or rather more than 24½ inches, middle rollers traverse a minute.

The speed of the back rollers of a throstle is required from the following particulars:—

Revolutions of front rollers a minute, 71.344.

Wheel on front rollers 20 teeth, working into large stud wheel 90 teeth; small stud wheel, or change pinion 23 teeth, working into wheel 46 teeth on back rollers.

71.344 revolutions of front rollers a min.
20 teeth wheel on front rollers.

1426.880
23 teeth wheel change pinion.

428064
285376

32818.24 dividend.

90 teeth wheel on stud.
46 teeth wheel on back rollers.

4140 divisor.

4140)32818.24(7.927 revolutions of back rollers a minute.
28980

38382
37260

11224
8280

29440
28980

460

If the back rollers of a throstle be $\frac{7}{8}$ inch diameter, making 7.927 revolutions a minute; what will they traverse?

7.927 revols. of back rollers a minute.
875 or $\frac{7}{8}$ inch diam. of back roller.

39635
55489
63416

6.936125
3.1416 circumference when diameter is 1.

41616750
6936125
27744500
6926125
20808375

21.7905303000, or rather more than $21\frac{3}{4}$ inches, back rollers traverse a minute.

If the back rollers of a throstle traverse 21.79 inches a minute, and the middle rollers 24.575 inches; what draught will there be?

21.79)24.575166(1.128 draught between back and middle rollers.
2179

2785
2179

6061 17036
4358 17432—nearly.

If the middle rollers of a throstle traverse 24.575166 inches a minute, and the front rollers 224.13431; what draught will there be between the middle and front rollers?

24.575)224.13431(9.12 draught between middle
221175 and front rollers.

29593
24575

50181
49150

1031

If the back rollers of a throstle traverse 21.79 inches a minute, and the front rollers 224.1343; what draught will there be between the front and back rollers?

21.79)224.1343(10.286 draught between the back
2179 and front rollers.

6234
4358

18763
17432

13310
13074

236

If the driving-wheels be 20 and 23, and the driven-wheels 90 and 46, the diameter of the front rollers 1 inch, and the back rollers $\frac{7}{8}$ inch; what draught will there be?

DRIVING-WHEELS.

20
23

460
Back roller $\frac{7}{8}$ inch, or 7

3220 divisor.

DRIVEN-WHEELS.
90
46

4140
8 = 1 inch front rollers.

3220)33120(10.286 nearly, draught in rols.
3220

9200
6440

27600
25760

18400
19320—nearly.

If one spindle produces 26 hanks, 4 leas, and 93$\frac{4}{10}$ yards, or 26.682622 hanks of twist a week; what length and weight of No. 30's twist will 6876 spindles produce?

26.682622 hanks a spindle a week.
6876 spindles.

160095733
186778355
213460977
160095733

No. of twist, 3.0's)18346.9.709988 hanks of twist a week.

6115.6569996℔s. of twist a week.
16 ounces 1 ℔.

39419976
6569996

10.5119936 ounces.
4 qrs. 1 oz.

2.0479744

Length of twist produced, 18346.97, nearly 18347 hanks.
Weight of twist produced, 6115℔s. 10$\frac{1}{2}$ oz. of No. 30's twist.

The speed of the mangle-wheel is required, from the following particulars:—

Revolutions of pulley-shaft a minute, 367.2.

Wheel on said shaft 32 teeth, working into stud-wheel 122 teeth; wheel on same stud 6 teeth, working into wheel 110 teeth on mangle-wheel-shaft; wheel 8 teeth on mangle-wheel-shaft, working into mangle-wheel 82 teeth.

122 teeth wheel on stud.
110 teeth wheel on mangle-wheel-shaft.

13420
82 teeth mangle-wheel.

26840
107360

1100440 divisor.

367.2 revolutions of pulley-shaft a minute.
32 teeth wheel on pulley-shaft.

7344
11016

11750.4
6 teeth wheel on stud.

70502.4
8 teeth wheel on mangle-wheel-shaft.

1100440)564019.2(.512539, or rather more than half a revolution of mangle-wheel a minute.
5502200

1379920
1100440

2794800
2200880

5939200
5502200

4370000
3301320

10686800
9903960

782840

The speed of the traverse-shaft is required, from the following particulars:—

Revolution of mangle-wheel a minute, .512539.

Wheel on mangle-wheel 21 teeth working racks, which works into wheel 43 teeth on traverse-shaft.

.51254 revolution of mangle-wheel a minute.
21 teeth on mangle-wheel, working racks.

51254
102508

Teeth of wl. on traverse-shaft, 43)10.76334(.25, or rather more than ¼ of a revolution of traverse-shaft a min.
86

216
215

1

What will the traverse move a minute, according to the following particulars:—

Revolution of traverse-shaft a minute, .25, or ¼.
Diameter of pulleys on traverse-shaft, 1½ inch.

3.1416 circumference when diameter is 1.
1.5, or 1½ inch diameter of pulleys on traverse-shaft.

157080
31416

4.71240
.25 or ¼ revolution of traverse-shaft.

235620
94248

1.178100, or rather more than 1⅙ inch, traverse moves a minute.

If the front rollers of a throstle traverse, or deliver 224.135 inches a minute, and the spindles make 4406.4 revolutions a minute, how many turns will there be in 1 inch of twist?

```
Deliv. a min., 224.135 in.)4406.400(19.65958 turns an inch for
                           224135              No. 30's twist.
                           -------
                           2165050
                           2017215
                           --------
                            1478350
                            1344810
                            --------
                             1335400
                             1120675
                             --------
                              2147250
                              2017215
                              --------
                               1300350
                               1120675
                               --------
                                1796750
                                1793080
                                --------
                                   3670
```

PARTICULARS OF A THROSTLE-FRAME.

Revolutions of a tin-drum, or cylinder for driving spindles a minute, 367.2.
Revolutions of spindles a minute, 4406.4.
Revolutions of front rollers a minute, 71.34426.
Revolutions of middle rollers a minute, 10.4304.
Revolutions of back rollers a minute, 7.927.
Revolution of mangle-wheel a minute, 0.51254.
Revolution of traverse-shaft a minute, 0.25.
Diameter of pulleys on drum, or cylinder-shaft, 10 inches.
Diameter of drum, or cylinder driving spindles, 12 inches.
Diameter of wharves, 1 inch.
Diameter of front rollers, 1 inch.
Diameter of middle rollers, $\frac{3}{4}$ inch.
Diameter of pulleys on traverse-shaft, 1½ inch.
Front rollers traverse or deliver a minute, 224.134 inches.
Middle rollers traverse a minute, 24.57 inches.
Back rollers traverse or consume a minute, 21.79 inches.
Traverse or bobbin rail moves a minute, 1.17956 inches.
Draught between back and middle rollers, 1.2878 nearly.

Draught between middle and front rollers, 9.12.
Total draught in rollers, 10.286.
Turns per inch for 30's twist, 19.659, or $19\frac{2}{3}$ nearly.
Hanks per spindle produced, 26 hanks, 4 leas, and $93\frac{4}{10}$ yards a week of sixty hours.

MULES.

The speed of the rim-shaft is required from the following particulars:—
Revolutions of shaft for driving upright-shaft in wheel-house, 86.
Diameter of drum on said shaft, 25 inches.
Diameter of pulley on upright-shaft in wheel-house, 12 inches.
Wheel on foot of upright-shaft in wheel-house 68 teeth, working into wheel 45 teeth on rim-shaft.

86 revolutions of shaft a minute.
25 inches diameter of drum on shaft.
———
430
172
———
2150
68 teeth wheel on foot of upright-shaft in wheel-house.
———
17200
12900
———
146200 dividend.

12 inches diameter of pulley on upright-shaft in [wheel-house.
45 teeth wheel on rim-shaft.
———
540 divisor.

54.0)14620.0(270.74 revolutions of rim-shaft a minute.
108
———
382
378
——— 220
400 216
378 ———
——— 4

Or thus, which is preferable when it can be divided by component parts:—

$$54.0\left\{\begin{array}{l}6)14620.0\\ \hline 9)2436.66\end{array}\right.$$

270.74 revolutions of rim-shaft a minute.

The speed of the front rollers is required, from the following particulars:—

Revolutions of rim-shaft a minute, 270.74.

Wheel on rim-shaft 50 teeth, working into wheel 64 teeth on top of long driver-shaft; wheel on bottom of long driver-shaft 40 teeth, working into wheel 80 teeth on front rollers.

270.74 revolutions of shaft a minute.
50 teeth wheel on shaft.

13537.00
40 teeth wheel on bottom of long driver.

541480 dividend.

64 teeth wheel on top of long driver.
80 teeth wheel on front rollers.

5120 divisor.

512.0)54148.0(105.75 revolutions of front rollers a minute.
512

2948
2560

3880
3584

2960
2560

400

If the front rollers be 1 inch diameter, making 105.75 revolutions a minute, what will they traverse?

105.75 revolutions of front rollers a minute.
3.1416 circumference when diameter is 1.

63450
10575
42300
10575
31725

332.224200, or $332\frac{11}{50}$ inches, front rollers traverse a minute.

The speed of the middle rollers is required, from the following particulars:—

Revolutions of front rollers a minute, 105.75.

Wheel on front rollers 24 teeth, working into wheel 100 teeth on shaft for driving back rollers; wheel on shaft for driving back rollers 25 teeth, working into wheel 50 teeth on back rollers; wheel on back rollers 24 teeth, working into carrying-wheel 40 teeth on stud, which works into wheel 21 teeth on middle rollers.

105.75 revolutions of front rollers a minute.
24 teeth wheel on front roller.

42300
21150

2538.00
25 teeth wheel (change pinion) on shaft driving back rollers.

12690
5076

63450
24 teeth wheel on back rollers.

253800
126900

1522800 dividend.

100 teeth wheel on shaft driving back rollers.
50 teeth wheel on back rollers.

5000
21 teeth wheel on middle rollers.

105000 divisor.

105.000)1522.800(14.5 revolutions of middle rollers a minute.
105

472
420

528
525

3

If the middle rollers be $\frac{7}{8}$ inch diameter, making $14\frac{1}{2}$ revolutions a minute; what will they traverse?

14.5 revolutions of middle rollers a minute.
.875, or $\frac{7}{8}$ inch diameter of rollers.

725
1015
1160

12.6875
3.1416 circumference when diameter is 1.

761250
126875
507500
126875
380625

39.85905000 inches, middle rollers traverse a min.

The speed of the back rollers is required from the following particulars:—

Revolutions of middle rollers a minute, 14.5 inches.
Wheel on middle roller 21 teeth, working into carrying-wheel 40 teeth on stud, which works into wheel 24 teeth on back rollers.

14.5 revolutions of middle rollers a minute.
21 teeth wheel on middle roller.

145
290

Teeth of wheel on mid. rols. } 24)304.5(12.6875 revolutions of back rollers a minute.
24

64
48

165
144

210
192

180
168

120
120

If the back rollers be ⅞ inch diameter, making 12.6875 revolutions a minute; what will they traverse?

12.6875 revolutions of back rollers a minute.
.875, or ⅞ inch diameter of rollers.

634375
888125
1015000

11.1015625
3.1416 circumference when diameter is 1.

666093750
111015625
444062500
111015625
333046875

34.87666875000, or 34⅞ inches, back rollers traverse a minute.

The draught between the back and middle rollers is required from the following particulars:—

Middle rollers traverse a minute, 39.859.
Back rollers traverse a minute, 34.876.

```
34.876)39.859(1.14288 draught between back and
       34876          middle rollers.
       -----
        49830
        34876
        ------
        149540
        139504
        ------
         100360
          69752
         ------
          306080
          279008
          -------
           270720
           279008—nearly.
```

The draught between the front and middle rollers is required from the following particulars :—

Front rollers traverse a minute, 332.2242 inches.
Middle rollers traverse a minute, 39.859 inches.

```
39.859)332.2242(8.3349 draught between front and mid. rols.
       318872
       ------
        133522
        119577
        ------
         139450
         119577
         ------
          198730
          159436
          ------
           392940
           358731
           ------
            34209
```

The draught between the front and back rollers is required from the following particulars:—

Front rollers traverse a minute, 332.2242 inches.
Back rollers traverse a minute, 34.8766 inches.

34.8766)332.2242(9.525 draught between back and front rollers.
3138894
1833480
1743830
896500
697532
1989680
1743830
245850

The draught in rollers at mules is required from the following particulars:—

Wheel on front rollers 24 teeth, working into wheel 100 teeth on shaft for driving back rollers; change wheel 25 teeth on same shaft, works into wheel 50 teeth on back rollers.
Diameter of back rollers, $\frac{7}{8}$ inch.
Diameter of front rollers, 1 inch.

DRIVING-WHEELS.

24 teeth wheel on front roller.
25 teeth wheel, or change pinion.
120
48
600
.875, or $\frac{7}{8}$ inch diameter of back rollers.
525.000 divisor.

DRIVEN-WHEELS.

100 teeth wheel on shaft for driving back rollers.
50 teeth wheel on do.
5000
1 inch diameter of front rollers.
5000 dividend.

525)5000(9.524 draught between back and front
4725 rollers.

2750
2625

1250
1050

2000
2100—nearly.

N. B.—The small difference between this and the last example, arises from the decimal fractions, which occur in the other system of working.

If the front rollers deliver 55 inches each stretch, which puts up 60 inches; the gain or draught in the carriage will be 5 inches, which is equal to $1\frac{1}{12}$ draught; the draught in the rollers is 9.524; what will the total draught be?

9.524 draught in rollers.
60 inches length of stretch.

Delivd. from rols. 55 in. $\begin{cases} 5)571.440 \\ 11)114.288 \end{cases}$

10.3899, or $10\frac{39}{100}$ (nearly), total draught at mules.

If the total draught at mules be 10.39, and the numbers to be spun 40's; the length required to be spun 20 hanks a spindle a week, the number of spindles in the mules 1000; what hank roving will be required, what number of hanks, and what weight?

RULE.

Multiply the number of spindles in the mules, by the number of hanks required a spindle, and the product will be the total number of hanks of yarn produced a week; which, divided by the draught, will give the number of hanks of roving required. Then divide the numbers of yarn by the draught in the mules, and the quotient will be the hank roving. Then divide the number of hanks of roving required to produce the given length of yarn, by the hank roving, and the quotient will be the weight of roving required.

EXAMPLE.

1000 number of spindles in mules.
20 hanks, length required a spindle.

20000 total number of hanks.

Hanks.
Draught 10.39)20000(1925 nearly, hanks of roving required.
1039

9610
9351

2590
2078

5120
5195—nearly.

Nos. of yarn.
Draught 10.39)40.00(3.85 hank roving required.
3117

8830
8312

5180
5195—nearly.

Hanks.
Hank roving, 3.85)1925(500℔s. net weight of roving required.
1925

The speed of the scroll is required from the following particulars:—

Revolutions of rim-shaft a minute, 270.74.
Wheel on rim-shaft 20 teeth, working into wheel 60 teeth on short driving-shaft.
Wheel on bottom end of short driving-shaft, 32 teeth, working into wheel 100 teeth on scroll-shaft.

270.74 revolutions of rim-shaft a min.
20 teeth wheel on rim-shaft.

5414.80
32 teeth wheel on bottom end of short driver.

108296
162444

173273.6 dividend.

60 teeth wheel on top of short driver.
100 teeth wheel on scroll-shaft.

6000 divisor.

6.000)173.273.6

28.879 nearly, revols. of scroll-shaft a min.

If the scroll makes 28.879 revolutions a minute, and be 4 inches diameter; what will it traverse?

28.879 revolutions of scroll a minute.
4 inches, diameter of scroll.

115.516
3.1416 circumference when diameter is 1.

693096
115516
462064
115516
346548

362.9050656 nearly 363 inches, scroll trav. a min.

The gain, or draught in carriage is required from the following particulars:—

Scroll traverses a minute, 362.9050656 inches.
Front rollers traverse a minute, 332.2242 inches.

332.2242)362.9050656(1.09235 gain, or draught in
3322242 carriage.

30680865
29900178

7806876
6644484

11623920
9966726

16571940
16611210—nearly.

By multiplying the draught in rollers, by the draught, or gain in carriage, it will give the total draught at mules.

If the length of the stretch be 61 inches, and the gain or draught in carriage be 1.09235, what length will the rollers deliver, and how many inches will the carriage gain a stretch?

Inches stretch.
Draught at carriage, 1.09235)61.00000(55.8429 inches, delivered
546175 at rollers a minute.

638250
546175

920750
873880

468700
436940

317600
218470

991300
983115

8185

61.0000 inches, length of stretch.
55.8429 inches, delivered at rollers.

5.1571 inches, carriage gains.

The speed of the spindles at mules is required from the following particulars:—

Revolutions of rim-shaft a minute, 270.74.
Diameter of rim, 23¼ inches.
Diameter of rim-band-pulley, 18¼ inches.
Diameter of twist-pulley, 14¼ inches.
Diameter of drums in carriage, 10 inches.
Diameter of wharves, ¾ inch.

270.74 revolutions of rim a minute.
23.25 inches, diameter of rim.

135370
54148
81222
54148

6294.7050
14.25 inches, diameter of twist-pulley.

31473525
12589410
25178820
6294705

89699.54625 dividend.

18.25 inches, diameter of rim-band-pulley.
.75, or ¾ inch, diameter of wharves.

9125
12775

13.6875 divisor.

13.687)89699.54625(65.536 revolutions of spindles at mules a minute.
82122
75775
68435
73404
68435
49696
41061
86352
82122
4230

If the scroll at a pair of mules traverse at the rate of 363 inches a minute, and the spindles make 6553 revolutions; how many turns an inch will there be in the yarn?

363)6553(18.05 turns an inch in yarn, while carriage is coming out.
363
2923
2904
1900
1815
85

How many turns will the rim make a stretch, if the front rollers deliver 57 inches, allowing the rim to make 271 revolutions, while the front rollers deliver 332.224 inches?

RULE.—Multiply the revolutions of the rim by the length of the stretch, and divide by the number of inches delivered at the front rollers, and the quotient will be the revolutions, or turns of rim a stretch.

271 revolutions of rim.
57 inches length of stretch.

1897
1355

Inches delivered, 332.224)15447.000(46.4957 revolutions, or turns of rim a stretch.
1328896

2158040
1993344

1646960
1328896

3180640
2990016

1906240
1661120

2451200
2325568

125632

To find the number of turns required for twist, or weft an inch.

RULE.—For twist, multiply the square root of the numbers, or counts of yarn by 3.75, or 3¾, and for weft, multiply the square root of the numbers, or counts of yarn by 3.25, or 3¼, and the products will be the turns an inch required.

What number of turns an inch will 44's twist require, according to the foregoing rule?

COUNTS.
44(6.633 square root of 44.
36

126)800
756

1323)4400
3969 39789

13263)43100 3311

6.633 square root of 44.
3.75, or 3¾.

33165
46431
19899

24.87375, or nearly 25 turns an inch, required for No. 44's twist.

What number of turns an inch will 36's weft require?

6 is the square root of 36.
3.25

19.50, or 19½ turns an inch required for 36's weft.

What number of turns an inch will 100's twist require?

10 is the square root of 100.
3.75

37.50, or 37½ turns an inch required for No. 100's twist.

The preceding rules for ascertaining the turns an inch required for twist and weft, have been generally adopted; however, where a good, or even a fair quality of cotton is used, the following rule will be found to answer, particularly for some qualities of yarns.

RULE.—Multiply the numbers, or counts of yarn by 12, the square root of which gives the turns an inch required for twist. Weft will require 3½, or 4 turns an inch less than twist.

N. B.—Some cotton requires more twist than others, according to its quality.

What number of turns an inch will be required for No. 50's twist, or weft, according to the above rule?

50's numbers, or counts of yarn.
12

600(25 turns nearly, required for 50's twist, less
4   3½ turns for weft.

45)200
225—nearly.

What number of turns an inch will be required for 100's twist, or weft?

100's numbers, or counts of yarn.
12
1200(34.64 turns an inch required for No. 100's twist, less 3½ turns, which will be equal to 31.14 turns an inch for 100's weft.
9
64)300
256
686)4400
4116
6924)28400
27696
704

RULE *for ascertaining the revolutions of spindles, for the rim* 1.—Multiply the diameters of the driving-pulleys together for a dividend, and the driven-pulleys accordingly for a divisor, and the quotient will be the revolutions of the spindles for the rim 1.

If the rim and rim-band-pulleys be each 22 inches diameter, the twist pulley 13½ inches, and the wharves ⅞ inch; what revolutions or turns will the spindles make for the rim 1?

N. B.—The rim and rim-band-pulley being of the same diameters are omitted in the working.

Diameter of wharves, .875)13.500(15.428 revolutions of spindles for rim 1.
875
4750
4375
3750
3500
2500
1750
7500
7000 500

If the rim be 33 inches diameter, the rim-band-pulley 26 inches, the twist-pulley 14¼ inches, and the wharves ¾ of an inch; what number of revolutions, or turns will the spindles make for the rim 1?

DRIVERS.

Twist-pulley, 14.25 inches.
Rim, 33 inches.

4275
4275

470.25 dividend.

DRIVEN.

26 inches drum-band-pulley.
.75, or ¾ inch wharves.

130
182

19.50 divisor.

195.)470.25(24.115 revols. of spindles for rim 1.
390

802
780

225
195

300
195

1050
975

75

BELL-WHEEL, OR REVOLUTIONS OF RIM A STRETCH.

RULE.—Multiply the turns required an inch, by the number of inches in the length of the stretch, for a dividend, and divide by the revolutions, or turns the spindles make for the rim 1, and the quotient will be the number of teeth for the bell-wheel, or revolutions of rim a stretch.

If 18.62 turns an inch be required, and the length of the stretch be 58 inches, the revolutions or turns of spindles 15.428 for the rim 1; what number of teeth must there be in the bell-wheel, or what revolutions must the rim make a stretch?

18.62 turns required an inch.
58 inches, length of stretch.

14896
9310

15.428)1079.96(70 teeth required for bell-wheel, or revolutions of rim a stretch.
107996

The turns an inch are required from the following particulars:—Bell-wheel, 70 teeth; rim, 22 inches diameter; rim-band-pulley, 22 inches diameter; twist-pulley, 13½ inches diameter; drums in carriage, 10 inches diameter; wharves, ⅞, or .875 inch diameter, and length of stretch, 58 inches.

N. B.—The rim, rim-band, pulley, and drum in carriage are omitted, on account of being drivers and driven of the same dimensions.

Multiply the number of teeth in the bell-wheel, by the diameters of the driving-pulleys respectively for a dividend; then multiply the number of inches in the length of a stretch, by the diameters of the driven-pulleys accordingly for a divisor, and the quotient will be the revolutions or turns an inch.

58 inches, length of stretch.
.875, or ⅞ inch, diameter of wharves.

7000
4375

50.750 divisor.

13.5 or 13½ inches, diameter of twist-pulley.
70 teeth bell-wheel, or revols. of rim a stretch.

94.5000

50.75)94.5000(18.62 turns an inch.
5075
43750
40600
31500
30450
10500
10150
350

If 26 turns an inch be required, and the length of the stretch be 61 inches; the revolutions, or turns of the spindles 24.115 for the rim 1; what number of teeth must there be in the bell-wheel, or what revolutions must the rim make a stretch?

26 turns an inch.
61 inches, length of stretch.
26
156
24.115)1586.000(65.768, or nearly 66 teeth required for bell-wheel, or revolutions of rim a stretch.
144690
139100
120575
185250
168805
164450
144690
197600
192920
4680

The turns an inch are required from the following particulars:—Bell-wheel, 66 teeth; length of stretch, 60 inches; diameter of rim, 33 inches; diameter of rim-band-pulley, 26 inches; diameter of twist-pulley, 14¼ inches; diameter of drums in carriage, 10 inches, and diameter of wharves, ¾ inch.

66 teeth bell-wheel.
33 inches, diameter of rim.

198
198

2178
14.25, or 14¼ inches, diameter of twist-pulley.

10890
4356
8712
2178

31036.50 dividend.

26 inches, diameter of twist-pulley.
60 inches, length of stretch.

1560
.75, or ¾ inch, diameter of wharves.

7800
10920

1170.00 divisor.

1170.)31036.5(26.52 turns an inch required.
2340

7636
7020

6165
5850

3150
2340

810

Whatever the principle of the mules is, any particular may be found by attending to the rules and examples illustrated.

N. B.—The general rules are exemplified with the different tables, and will appear in their regular course.

TABLES,

Showing the size, hank, and proportion of hank in every operation, from the lap machine through all the various processes of carding, drawing, slabbing, roving and spinning, with practical rules and examples.

EXPLANATION OF THE CARDING AND DRAWING-TABLES.

The first line in the carding and drawing-table is the decimal of the hank according to its length and weight, which will be found in the following manner: Multiply all the draughts together as far as regards the operation you intend trying, whether it be slabbing, drawing, or carding, for a dividend, and all the doubling accordingly for a divisor, the quotient will be the draught; then divide the numbers you are spinning, or the numbers you wish to spin, by the net draught, and the quotient will be the decimal of the hank; opposite to which in the table, you will have the weight according to the length weighed.

EXAMPLE.

Suppose the total draught to be 181440, the doubling 1728, and the numbers to be spun 40's; what weight will 2 yards of carding, or doubling be?

1728)181440(105 draught more than doubling.
1728
——
8640
8640

Draught more than doubling, } Counts. 105)40.0(0.38 decimal of a hank. Opposite to which in the table under 2 yards will be found, 1 dwt. 19.8 grains, the weight required.
315
——
850
840
——
10

CARDING AND DRAWING-TABLE.

From .05 to .089 decimal of hank for 2, 4, and 6 yards.

Dec. of hank.	2 yards.		Dec. of hank.	4 yards.			Dec. of hank.	6 yards.		
	dwts.	grains.		oz.	dwts.	grains.		oz.	dwts.	grains.
.05	13	21.33	.05	1	9	13.16	.05	2	5	5.
.051	13	14.78	.051	1	9	0.06	.051	2	4	9.35
.052	13	8.51	.052	1	8	11.52	.052	2	3	14.53
.053	13	2.46	.053	1	7	23.43	.053	2	2	20.39
.054	12	20.64	.054	1	7	11.78	.054	2	2	2.92
.055	12	15.03	.055	1	7	0.56	.055	2	1	10.09
.056	12	9.61	.056	1	6	13.73	.056	2	0	17.85
.057	12	4.39	.057	1	6	3.29	.057	2	0	2.18
.058	11	23.35	.058	1	5	17.21	.058	1	17	16.56
.059	11	18.48	.059	1	5	7.47	.059	1	17	1.95
.06	11	13.77	.06	1	4	22.05	.06	1	16	11.83
.061	11	9.22	.061	1	4	12.94	.061	1	15	22.17
.062	11	4.81	.062	1	4	4.13	.062	1	15	8.95
.063	11	0.55	.063	1	3	19.6	.063	1	14	20.15
.064	11	20.41	.064	1	3	11.33	.064	1	14	7.74
.065	10	16.41	.065	1	3	3.32	.065	1	13	19.73
.066	10	12.52	.066	1	2	19.55	.066	1	13	8.07
.067	10	8.75	.067	1	2	12.01	.067	1	12	20.76
.068	10	5.09	.068	1	2	4.69	.068	1	12	9.79
.069	10	1.45	.069	1	1	21.41	.069	1	11	22.87
.07	9	22.09	.07	1	1	14.69	.07	1	11	12.5
.071	9	18.74	.071	1	1	7.98	.071	1	11	2.72
.072	9	15.89	.072	1	1	2.29	.072	1	10	18.19
.073	9	12.31	.073	1	0	19.12	.073	1	10	7.43
.074	9	9.22	.074	1	0	12.95	.074	1	9	22.17
.075	9	6.22	.075	1	0	6.94	.075	1	9	13.21
.076	9	3.29	.076	1	0	1.1	.076	1	9	4.39
.077	9	0.45	.077		18	0.9	.077	1	8	19.85
.078	8	21.67	.078		17	19.35	.078	1	8	11.52
.079	8	18.97	.079		17	13.94	.079	1	8	3.41
.08	8	16.33	.08		17	8.66	.08	1	7	19.5
.081	8	13.76	.081		17	3.52	.081	1	7	11.78
.082	8	11.25	.082		16	22.5	.082	1	7	4.25
.083	8	8.8	.083		16	17.6	.083	1	6	20.9
.084	8	6.41	.084		16	12.82	.084	1	6	13.37
.085	8	4.07	.085		16	8.15	.085	1	6	6.73
.086	8	1.79	.086		16	3.59	.086	1	5	23.89
.087	7	23.57	.087		15	23.14	.087	1	5	17.21
.088	7	21.39	.088		15	18.78	.088	1	5	10.68
.089	7	19.26	.089		15	14.53	.089	1	5	4.29

What will 8 yards of .08, or $\frac{8}{100}$ hank weigh?
Proportion of hank, .08)66.66

No. of grains in 1 oz., 437.5)833.33 grains,(1 oz.
437.5

1 dwt. is 24 grains,)395.83(16 dwts.
24

155
144

11.83 grains.

Weight of 8 yards of .08 decimal of hank drawing, will be 1 oz., 16 dwts., 11.83 grains.

If 8 yards of drawing weigh 1 oz., 16 dwts., 11.83 grains, what size or proportion of hank will it be?

1 ounce 437.5 grains.
16 dwts. x 24 grains 384. grains.
11.833 grains.

1 oz., 16 dwts., 11.83 grains, 833.333
The dividend for 8 yards is 66.666.
833.33)66.6666(.08 decimal of a hank, or size of
666666 drawing.

What will 6 yards of .1, or $\frac{1}{10}$ hank drawing weigh?
Dividend for 6 yards is 50. (See Table of Dividends.)
0.1)50,

500 grains weight.
1 ounce,437.5 grains,)500.0(1 oz.
437.5

1 dwt. is 24 grains,)62.5(2 dwts.
48

14.5 grains.

Weight of 6 yards of 0.1, or $\frac{1}{10}$ hank drawing, will weigh 1 oz., 2 dwts., 14½ grains.

CARDING AND DRAWING-TABLE.

From .09 to .129 decimal of hank for 2, 4, and 6 yards.

Dec. of hank.	2 yards.		Dec. of hank.	4 yards.			Dec. of hank.	6 yards.		
	dwts.	grains.		oz.	dwts.	grains.		oz.	dwts.	grains.
.09	7	17.18	.09		15	10.37	.09	1	4	22.05
.091	7	15.15	.091		15	6.3	.091	1	4	15.95
.092	7	13.15	.092		15	2.31	.092	1	4	9.97
.093	7	11.21	.093		14	22.42	.093	1	4	4.13
.094	7	9.3	.094		14	18.6	.094	1	3	22.41
.095	7	7.43	.095		14	14.87	.095	1	3	16.81
.096	7	5.61	.096		14	11.22	.096	1	3	11.33
.097	7	3.82	.097		14	7.64	.097	1	3	5.96
.098	7	2.06	.098		14	4.13	.098	1	3	0.7
.099	7	0.35	.099		14	0.7	.099	1	2	19.55
.1	6	22.66	.1		13	21.33	.1	1	2	14.5
.101	6	21.01	.101		13	18.03	.101	1	2	9.05
.102	6	19.39	.102		13	14.79	.102	1	2	4.69
.103	6	17.81	.103		13	11.62	.103	1	1	23.93
.104	6	16.25	.104		13	8.51	.104	1	1	19.26
.105	6	14.72	.105		13	5.46	.105	1	1	14.68
.106	6	13.13	.106		13	2.27	.106	1	1	9.91
.107	6	11.76	.107		12	23.52	.107	1	1	5.78
.108	6	10.32	.108		12	20.64	.108	1	1	1.46
.109	6	8.9	.109		12	17.81	.109	1	0	21.21
.11	6	7.51	.11		12	15.03	.11	1	0	17.04
.111	6	6.15	.111		12	12.3	.111	1	0	12.95
.112	6	4.98	.112		12	9.97	.112	1	0	9.46
.113	6	3.49	.113		12	6.98	.113	1	0	4.97
.114	6	2.19	.114		12	4.39	.114	1	0	1.09
.115	6	0.92	.115		12	1.85	.115		18	2.78
.116	5	23.67	.116		11	23.35	.116		17	23.03
.117	5	22.45	.117		11	20.9	.117		17	19.35
.118	5	21.24	.118		11	18.48	.118		17	15.72
.119	5	20.05	.119		11	16.11	.119		17	12.16
.12	5	18.88	.12		11	13.77	.12		17	8.66
.121	5	17.74	.121		11	11.48	.121		17	5.22
.122	5	16.61	.122		11	9.22	.122		17	1.83
.123	5	15.5	.123		11	7.	.123		16	22.5
.124	5	14.4	.124		11	4.81	.124		16	19.22
.125	5	13.33	.125		11	2.66	.125		16	16.
.126	5	12.27	.126		11	0.5	.126		16	12.82
.127	5	11.23	.127		10	22.46	.127		16	9.7
.128	5	10.2	.128		10	20.41	.128		16	6.62
.129	5	9.19	.129		10	18.39	129		16	3.59

The following will be the dividends, according to the number of yards for ascertaining the weight of any decimal part of a hank.

Yards.	Dividends.
1	8.333
2	16.666
3	25.
4	33.333
5	41.666
6	50.
7	58.333
8	66.666
9	75.
10	83.333
15	125.
20	166.
30	250.
40	333.333
60	500.
80	666.666
120	1000.

RULE.—Divide the dividend by the hank, or decimal part of a hank, according to the number of yards weighed, and the quotient will be the weight in grains.

What will 2 yards of 0.13 of a hank weigh?

Dividend for 2 yards.
13)16.666(128.2 grains, or 5 dwts., 8.2 grains,
13 weight of 2 yards.

36
26

106
104

26
26

CARDING AND DRAWING-TABLE.

From .13 to .187 decimal of hank for 2, 4, and 6 yards.

Dec. of hank.	2 yards.		Dec. of hank.	4 yards.			Dec. of hank.	6 yards.		
	dwts.	grains.		oz.	dwts.	grains.		oz.	dwts.	grains.
.13	5	8.2	.13		10	16.4	.13		16	0.6
.131	5	7.22	.131		10	14.45	.131		15	21.67
.132	5	6.26	.132		10	12.5	.132		15	18.78
.133	5	5.31	.133		10	10.62	.133		15	15.93
.134	5	4.37	.134		10	8.75	.134		15	13.13
.135	5	3.45	.135		10	6.91	.135		15	10.37
.136	5	2.55	.136		10	5.2	.136		15	7.74
.137	5	1.65	.137		10	3.3	.137		15	4.96
.138	5	0.77	.138		10	1.54	.138		15	2.31
.139	4	23.9	.139		9	23.8	.139		14	23.7
.14	4	23.	.14		9	22.	.14		14	21.
.141	4	22.2	.141		9	20.4	.141		14	18.6
.142	4	21.37	.142		9	18.74	.142		14	16.11
.143	4	20.55	.143		9	17.1	.143		14	13.65
.144	4	19.74	.144		9	15.48	.144		14	11.22
.145	4	12.94	.145		9	13.88	.145		14	8.82
.146	4	18.15	.146		9	12.31	.146		14	6.46
.147	4	17.37	.147		9	10.75	.147		14	4.13
.148	4	16.61	.148		9	9.22	.148		14	1.83
.149	4	15.85	.149		9	7.71	.149		13	23.57
.15	4	15.11	.15		9	6.22	.15		13	21.33
.151	4	14.37	.151		9	4.75	.151		13	19.12
.1525	4	13.29	.1525		9	2.57	.1525		13	15.86
.153	4	12.93	.153		9	1.86	.153		13	14.79
.155	4	11.52	.155		8	23.05	.155		13	10.58
.157	4	10.15	.157		8	20.31	.157		13	6.47
.1575	4	9.82	.1575		8	19.6	.1575		13	5.46
.159	4	8.82	.159		8	17.64	.159		13	2.46
.16	4	8.16	.16		8	16.33	.16		13	0.5
.163	4	6.24	.163		8	12.49	.163		12	18.74
.165	4	5.1	.165		8	10.2	.165		12	15.3
.167	4	3.8	.167		8	7.6	.167		12	11.4
.17	4	2.	.17		8	4.	.17		12	6.
.173	4	0.33	.173		8	0.67	.173		12	1.01
.175	3	23.32	.175		7	22.65	.175		11	21.98
.179	3	21.1	.179		7	18.21	.179		11	15.32
.18	3	20.59	.18		7	17.18	.18		11	13.77
.183	3	19.07	.183		7	14.14	.183		11	9.22
.185	3	18.1	.185		7	12.18	.185		11	6.27
.187	3	17.12	.187		7	10.25	.187		11	3.37

What will 4 yards of 0.26 of a hank weigh?

```
0.26)33.333(128.2 grains, or 5 dwts., 8.2 grains.
     26
     --
      73
      52
      ---
      213
      208
      ---
        53
        52
        --
         1
```

What will 6 yards of 0.335 of a hank weigh?

```
0.335)50.000(149.25 grains, or 6 dwts. 5¼ grains.
      335
      ----
      1650
      1340
      ----
       3100
       3015
       ----
         850
         670
         ----
         1800
         1675
         ----
          125
```

If 6 yards of carding, or drawing weigh 6 dwts., 5¼ grains, what will the decimal of the hank be?

```
6 dwts. 5¼ grs.=149.25 grs.)50.0000(0.335 decimal of a hank,
                            44775
                            -----
                             52250
                             44775
                             -----
                              74750
                              74625
                              -----
                                125
```

and opposite which in the table under 6 yards will be found 6 dwts. 5¼ grains.

CARDING AND DRAWING-TABLE.

From .19 to .31 decimal of hank for 2, 4, and 6 yards.

Dec. of hank.	2 yards.		Dec. of hank.	4 yards.			Dec. of hank.	6 yards.		
	dwts.	grains.		oz.	dwts.	grains.		oz.	dwts.	grains.
.19	3	15.71	.19		7	7.43	.19		10	23.15
.193	3	14.35	.193		7	4.71	.193		10	19.06
.195	3	13.47	.195		7	2.94	.195		10	16.41
.197	3	12.6	.197		7	1.2	.197		10	13.8
.2	3	11.33	.2		6	22.66	.2		10	10.
.203	3	10.09	.203		6	20.2	.203		10	6.3
.205	3	9.3	.205		6	18.6	.205		10	3.9
.207	3	8.51	.207		6	17.03	.207		10	1.54
.21	3	7.36	.21		6	14.73	.21		9	22.1
.213	3	6.24	.213		6	12.49	.213		9	18.74
.215	3	5.51	.215		6	11.03	.215		9	16.55
.217	3	4.8	.217		6	9.6	.217		9	14.41
.22	3	3.75	.22		6	7.51	.22		9	11.27
.223	3	2.73	.223		6	5.46	.223		9	8.21
.225	3	2.07	.225		6	4.14	.225		9	6.22
.227	3	1.42	.227		6	2.84	.227		9	4.26
.23	3	0.46	.23		6	0.92	.23		9	1.38
.233	2	23.53	.233		5	23.06	.233		8	22.59
.235	2	22.92	.235		5	21.84	.235		8	20.76
.237	2	22.32	.237		5	20.64	.237		8	18.97
.24	2	21.44	.24		5	18.88	.24		8	16.33
.243	2	20.58	.243		5	17.17	.243		8	13.76
.245	2	20.02	.245		5	16.04	.245		8	12.06
.247	2	19.47	.247		5	14.95	.247		8	10.42
.25	2	18.66	.25		5	13.33	.25		8	8.
.253	2	17.87	.253		5	11.75	.253		8	5.62
.255	2	17.36	.255		5	10.71	.255		8	4.07
.257	2	16.85	.257		5	9.7	.257		8	2.55
.26	2	16.1	.26		5	8.2	.26		8	0.3
.263	2	15.37	.263		5	6.74	.263		7	22.11
.265	2	14.89	.265		5	5.78	.265		7	20.67
.27	2	13.72	.27		5	3.45	.27		7	17.18
.275	2	12.6	.275		5	1.21	.275		7	13.81
.28	2	11.52	.28		4	23.04	.28		7	10.56
.285	2	10.47	.285		4	20.95	.285		7	7.43
.29	2	9.47	.29		4	18.94	.29		7	4.41
.295	2	8.49	.295		4	16.99	.295		7	1.49
.3	2	7.55	.3		4	15.11	.3		6	22.66
.305	2	6.64	.305		4	13.28	.305		6	19.93
.31	2	5.76	.31		4	11.52	.31		6	17.28

Suppose 2 yards of carding, or drawing weigh 2 dwts., 20 grains, or 68 grains; what proportion of a hank will it be? Thus 2 yards is $\frac{1}{60}$ of a lea, which is equal to 16.666 grains, which must be divided by the weight 2 yards, which is 68 grains.

2 dwts., 20 grains, = 68 grns.)16.666(.245 decimal, or proportion
136 of a hank.
306
272
346
340
6

What will 6 yards of 0.4 hank drawing weigh?
0.4)50.00
125 grains, or 5 dwts., 5 grains.

If 6 yards of carding, or drawing weigh 5 dwts., 5 grains; what proportion of a hank will it be?
5 dwts., 5 grains, = 125 grains,)50.000(0.4 proportion of hank.
500

What will 3 yards of 0.7 hank carding, or drawing weigh?
Decimal of a hank, 0.7)25.00
1 dwt., is 24 grns.)35.71(1 dwt., 11.7 grains weight.
24
11.71

What will 4 yards of 0.7 hank carding, or drawing weigh?
Decimal of hank 0.7)33.333
24)47.619(1 dwt., 23.6 grains weight.
24
23.6

CARDING AND DRAWING-TABLE.

From .315 to .95 decimal of hank for 2, 4, and 6 yards.

Dec. of hank.	2 yards.		Dec. of hank.	4 yards.			Dec. of hank.	6 yards.		
	dwts.	grains.		oz.	dwts.	grains.		oz.	dwts.	grains.
.315	2	4.91	.315		4	9.82	.315		6	14.73
.32	2	4.08	.32		4	8.16	.32		6	12.24
.325	2	3.28	.325		4	6.56	.325		6	9.84
.33	2	2.5	.33		4	5.01	.33		6	7.51
.335	2	1.75	.335		4	3.5	.335		6	5.25
.34	2	1.	.34		4	2.	.34		6	3.
.345	2	0.3	.345		4	0.61	.345		6	0.92
.35	1	23.61	.35		3	23.23	.35		5	22.85
.355	1	22.94	.355		3	21.89	.355		5	20.94
.36	1	22.29	.36		3	20.59	.36		5	18.88
.365	1	21.66	.365		3	19.22	.365		5	16.98
.37	1	21.04	.37		3	18.09	.37		5	15.13
.375	1	20.44	.375		3	16.88	.375		5	13.32
.38	1	19.86	.38		3	15.71	.38		5	11.58
.385	1	19.29	.385		3	14.58	.385		5	9.87
.39	1	18.73	.39		3	13.47	.39		5	8.2
.395	1	18.19	.395		3	12.38	.395		5	6.58
.4	1	17.66	.4		3	11.33	.4		5	5.
.41	1	16.65	.41		3	9.3	.41		5	1.95
.42	1	15.68	.42		3	7.36	.42		4	23.05
.43	1	14.75	.43		3	5.51	.43		4	20.28
.44	1	13.87	.44		3	3.75	.44		4	17.63
.45	1	13.03	.45		3	2.07	.45		4	15.11
.46	1	12.23	.46		3	0.46	.46		4	12.69
.47	1	11.46	.47		2	22.92	.47		4	10.38
.48	1	10.72	.48		2	21.44	.48		4	8.16
.49	1	10.01	.49		2	20.02	.49		4	6.04
.5	1	9.33	.5		2	18.66	.5		4	4.
.52	1	8.05	.52		2	16.1	.52		4	0.15
.54	1	6.86	.54		2	13.72	.54		3	20.59
.56	1	5.76	.56		2	11.52	.56		3	17.28
.58	1	4.73	.58		2	9.47	.58		3	14.2
.6	1	3.77	.6		2	7.55	.6		3	11.33
.65	1	1.64	.65		2	3.28	.65		3	4.92
.7		23.8	.7		1	23.6	.7		2	23.42
.75		22.22	.75		1	20.44	.75		2	18.66
.8		20.83	.8		1	17.66	.8		2	14.5
.85		19.6	.85		1	15.21	.85		2	10.82
.9		18.51	.9		1	13.04	.9		2	7.55
.95		17.54	.95		1	11.08	.95		2	4.62

If 8 yards of drawing weigh 1 oz., 7 dwts., 0.5 grains; what decimal part of a hank will it be?

Then 18 dwts. 5½ grains troy is equal to 1 oz. avoirdupois; therefore 1 oz., 7 dwts., 0.5 grains will be equal to 25 dwts., 6 grains troy, or 606 grains, which will be the divisor, and 8 yards which is $\frac{1}{15}$ of a lea, or 66.666 grains, will be the dividend.

```
606 grains,)66.666(0.11 decimal of a hank.
            606
            ———
             606
             606
```

If 10 yards of carding, or drawing weigh 1 oz., 12 dwts., 18.5 grains; what decimal of a hank will it be?

```
                Grains.
  1 ounce  =  437.5
 12  dwts. =  288
               18.5
             ——————
              744 grains, in 1 oz., 12 dwts., 18½ grains.

744 grains,)83.333(0.112 decimal of a hank.
            744
            ———
            893
            744
            ————
            1493
            1488
            ————
               5
```

What will 8 yards of 0.112 of a hank drawing weigh?

Dividend.
0.112)66.666(595.2 grains.
560
1066
1008
586
560
266
224
42

1 oz. is 437.5 grs.)595.2(1 oz.
437.5
1 dwt. is 24 grs.)157.7(6 dwts.
144
13.7 grains.

OR,

1 oz. 6 dwts., 13.7 grains.

CARDING AND DRAWING-TABLE.

From .066 to .11 decimal of hank for 8 and 10 yards.

Dec. of hank.	8 yards.			Dec. of hank.	10 yards.		
	oz.	dwts.	grains.		oz.	dwts.	grains.
.066	2	5	15.1	.066	2	16	3.6
.067	2	5	0.	.067	2	15	8.7
.068	2	4	9.4	.068	2	14	14.4
.069	2	3	19.1	.069	2	13	20.7
.07	2	3	5.3	.07	2	13	3.3
.071	2	2	15.9	.071	2	12	10.7
.072	2	2	2.9	.072	2	11	18.4
.073	2	1	14.2	.073	2	11	2.5
.074	2	1	2.	.074	2	10	11.1
.075	2	0	13.8	.075	2	9	20.1
.076	2	0	2.2	.076	2	9	5.4
.077	1	17	20.3	.077	2	8	15.2
.078	1	17	9.2	.078	2	8	1.3
.079	1	16	22.3	.079	2	7	11.8
.08	1	16	11.8	.08	2	6	22.6
.081	1	16	1.5	.081	2	6	9.8
.082	1	15	15.5	.082	2	5	21.2
.083	1	15	5.7	.083	2	5	9.
.084	1	14	20.1	.084	2	4	21.
.085	1	14	10.8	.085	2	4	9.3
.086	1	14	1.6	.086	2	3	21.8
.087	1	13	16.7	.087	2	3	10.9
.088	1	13	8.	.088	2	2	23.3
.089	1	12	23.5	.089	2	2	13.2
.09	1	12	15.2	.09	2	2	2.7
.091	1	12	7.1	.091	2	1	16.7
.092	1	11	23.1	.092	2	1	6.3
.093	1	11	15.3	.093	2	0	21.
.094	1	11	7.7	.094	2	0	11.5
.095	1	11	0.2	.095	2	0	2.1
.096	1	10	16.9	.096	1	17	22.5
.097	1	10	9.7	.097	1	17	13.6
.098	1	10	2.7	.098	1	17	4.8
.099	1	9	19.9	.099	1	16	20.2
.1	1	9	13.1	.1	1	16	11.8
.102	1	9	0.	.102	1	15	19.4
.104	1	8	11.5	.104	1	15	3.7
.106	1	7	23.4	.106	1	14	12.6
.108	1	7	11.7	.108	1	13	22.1
.11	1	7	0.5	.11	1	13	8.

When the proportion or decimal of the hank is found, the following table will show the dividend for any number of inches in length, from 1 to 36 inches, when the quotient will be the weight in grains:—

Inches.	Dividends.	Inches.	Dividends.
1	.23148	19	4.39812
2	.46296	20	4.6296
3	.69444	21	4.86108
4	.92592	22	5.09256
5	1.15740	23	5.32404
6	1.38888	24	5.55555
7	1.62036	25	5.787
8	1.85184	26	6.01848
9	2.08332	27	6.24996
10	2.3148	28	6.48144
11	2.54628	29	6.71292
12	2.77777	30	6.9444
13	3.00924	31	7.17588
14	3.24072	32	7.40736
15	3.4722	33	7.63884
16	3.70368	34	7.87032
17	3.93516	35	8.1018
18	4.16666	36	8.3333

N. B.—The above tables will show the dividends for any number of inches of lap, or cotton fed on feed-cloth at lap machine; the quotient of which will be the weight in grains; the divisor must be invariably the decimal, or proportion of the hank.

If the decimal, or proportion of the hank at the lap machine, according to the draught and doubling, be 0.0005; what weight of cotton must be fed on 12 inches of feed-cloth at lap machine?

Thus—Dec. of hank, 0.0005)2.7777 dividend for 12 inches.

5555.5 grains, or 12 oz., 12 dwts., 17½ grains, the weight of cotton required.

N. B.—The loss sustained in working must be added to the net weight according to the number of hanks produced.

CARDING AND DRAWING-TABLE.

From .112 to .24 decimal of hank for 8 and 10 yards.

Dec. of hank.	8 yards.			Dec. of hank.	10 yards.		
	oz.	dwts.	grains.		oz.	dwts.	grains.
.112	1	6	13.7	.112	1	12	18.5
.114	1	6	3.2	.114	1	12	5.4
.116	1	5	17.2	.116	1	11	16.8
.118	1	5	7.4	.118	1	11	4.7
.12	1	4	22.	.12	1	10	16.6
.122	1	4	12.9	.122	1	10	5.5
.124	1	4	4.2	.124	1	9	18.5
.126	1	3	19.6	.126	1	9	7.8
.128	1	3	11.3	.128	1	8	21.5
.13	1	3	3.3	.13	1	8	11.5
.132	1	2	19.5	.132	1	8	1.8
.134	1	2	12.	.134	1	7	15.6
.136	1	2	4.6	.136	1	7	7.2
.138	1	1	21.5	.138	1	6	22.3
.14	1	1	14.6	.14	1	6	13.7
.142	1	1	7.9	.142	1	6	5.3
.144	1	1	0.7	.144	1	5	21.2
.146	1	0	19.1	.146	1	5	12.6
.148	1	0	12.9	.148	1	5	6.
.15	1	0	6.9	.15	1	4	22.
.1525		18	5.1	.1525	1	4	12.9
.155		17	22.1	.155	1	4	4.1
.1575		17	15.2	.1575	1	3	19.6
.16		17	8.6	.16	1	3	11.3
.165		16	20.	.165	1	2	19.5
.17		16	8.1	.17	1	2	4.5
.175		15	20.9	.175	1	1	14.6
.18		15	10.	.18	1	1	1.4
.185		15	0.3	.185	1	0	12.9
.19		14	14.8	.19	1	0	1.1
.195		14	5.8	.195		17	19.3
.2		13	21.3	.2		17	8.6
.205		13	13.2	.205		16	22.5
.21		13	5.4	.21		16	12.8
.215		12	22.	.215		16	3.5
.22		12	15.	.22		15	18.7
.225		12	8.2	.225		15	10.3
.23		12	1.8	.23		15	2.3
.235		11	19.6	.235		14	18.6
.24		11	13.7	.24		14	11.2

If 8 yards of carding, or drawing weigh 16 dwts., 20 grains; what proportion, or size of hank will it be?

Then 16 dwts., 20 grains are equal to 404 grains, which will be the divisor; and 8 yards are $\frac{1}{15}$ of a lea, or 66.666 grains, which will be the dividend.

404)66.666(0.165 decimal, or proportion of hank,
404 opposite to which in the table
—— under 8 yards, is 16 dwts., 20
2626 grains, the weight.
2424
——
2026
2020
——
6

If 8 yards of carding or drawing weigh 4 dwts., 5 grains; what proportion, or size of hank will it be?

4 dwts., 5 grs, are equal to 101 grs.)66.666(0.66 proportion, or
606 size of hank.
——
606
606

What will 8 yards of 0.165 of a hank of carding, or drawing weigh?

Then 8 yards are $\frac{1}{15}$ of a lea, which is equal to 66.666 grains, which will be the dividend, and the decimal of the hank 0.165 the divisor.

0.165)66.666(404 grains, or 16 dwts., 20 grains, which
660 will be found in the column under 8
—— yards; to the left hand of which will
666 be found 0.165, which is the decimal,
660 or size of a hank for 8 yards of card-
—— ing or drawing that weighs 16 dwts.
6 20 grains.

CARDING AND DRAWING-TABLE.

From .245 to .48 decimal of hank for 8 and 10 yards.

Dec. of hank.	8 yards.			Dec. of hank.	10 yards.		
	oz.	dwts.	grains.		oz.	dwts.	grains.
.245		11	8.1	.245		14	4.
.25		11	2.6	.25		13	21.3
.255		10	21.4	.255		13	14.7
.26		10	16.4	.26		13	8.5
.265		10	11.5	.265		13	2.4
.27		10	6.9	.27		12	20.6
.275		10	2.4	.275		12	15.
.28		9	22.	.28		12	9.6
.285		9	17.9	.285		12	4.3
.29		9	13.8	.29		11	23.3
.295		9	9.9	.295		11	18.4
.3		9	6.2	.3		11	13.7
.305		9	2.5	.305		11	9.2
.31		8	23.	.31		11	4.8
.315		8	19.6	.315		11	0.5
.32		8	16.3	.32		10	20.4
.325		8	13.1	.325		10	16.4
.33		8	10.	.33		10	12.5
.335		8	7.	.335		10	8.7
.34		8	4.	.34		10	5.
.345		8	1.2	.345		10	1.5
.35		7	22.4	.35		9	22.
.355		7	19.7	.355		9	18.7
.36		7	17.1	.36		9	15.4
.365		7	14.6	.365		9	12.3
.37		7	12.1	.37		9	9.2
.375		7	9.7	.375		9	6.2
.38		7	7.4	.38		9	3.3
.385		7	5.1	.385		9	0.4
.39		7	2.9	.39		8	21.6
.395		7	0.7	.395		8	18.9
.4		6	22.6	.4		8	16.3
.41		6	18.6	.41		8	11.2
.42		6	14.7	.42		8	6.4
.43		6	11.	.43		8	1.8
.44		6	7.5	.44		7	21.3
.45		6	4.1	.45		7	17.1
.46		6	0.9	.46		7	13.1
.47		5	21.8	.47		7	9.3
.48		5	18.8	.48		7	5.6

What will 18 yards of $1\frac{1}{4}$ hank slabbing weigh?

Then 18 yards is $\frac{3}{20}$ of a lea, or 120 yards, which is equal to 150 grains of a 1 hank, which, divided by $1\frac{1}{4}$, or 1.25, will give the weight in grains that 18 yards should weigh.

Grains.
Hank slabbing 1.25)150.0(120 grains, or 5 dwts., weight
125 required.
250
250

If 18 yards of slabbing weigh 5 dwts., or 120 grains; what hank will it be?

120)150.00(1.25 hank slabbing.
120
300
240
600
600

What will 37 yards of $1\frac{3}{4}$ hank slabbing weigh?

Then 37 yards is $\frac{37}{120}$ of a lea, or 120 yards, which is equal to 308.333 grains of a 1 hank, which, divided by $1\frac{3}{4}$, or 1.75, will give the weight in grains that 37 yards should weigh.

1.75)308.3333(176.19 grains, or 7 dwts., 8.19
175 grs., weight required.
1333
1225
1083
1050
333
175
1583
1575
8

CARDING, DRAWING, AND SLABBING-TABLE.

From .5 to .99 decimal of hank for 8, 10, and 20 yards.

Dec. of hank.	8 yards.		Dec. of hank.	10 yards.			Dec. of hank.	20 yards.		
	dwts.	grains.		oz.	dwts.	grains.		oz.	dwts.	grains.
.5	5	13.3	.5		6	22.6	.5		13	21.2
.51	5	10.7	.51		6	19.4	.51		13	14.8
.52	5	8.2	.52		6	16.2	.52		13	8.4
.53	5	5.7	.53		6	13.2	.53		13	2.4
.54	5	3.4	.54		6	10.3	.54		12	20.6
.55	5	1.2	.55		6	7.5	.55		12	15.
.56	4	23.	.56		6	4.8	.56		12	9.6
.57	4	20.9	.57		6	2.2	.57		12	4.4
.58	4	18.9	.58		5	23.6	.58		11	23.2
.59	4	17.	.59		5	21.2	.59		11	18.4
.6	4	15.1	.6		5	18.8	.6		11	13.6
.62	4	11.5	.62		5	14.4	.62		11	4.8
.64	4	8.1	.64		5	10.2	.64		10	20.4
.66	4	5.	.66		5	6.	.66		10	12.
.68	4	2.	.68		5	2.5	.68		10	5.
.7	3	23.2	.7		4	23.	.7		9	22.
.72	3	20.6	.72		4	19.6	.72		9	15.2
.74	3	18.	.74		4	16.6	.74		9	9.2
.76	3	15.7	.76		4	13.6	.76		9	3.2
.78	3	13.4	.78		4	10.8	.78		8	21.6
.8	3	11.3	.8		4	8.1	.8		8	16.2
.81	3	10.3	.81		4	6.8	.81		8	13.7
.82	3	9.3	.82		4	5.6	.82		8	11.2
.83	3	8.2	.83		4	4.3	.83		8	8.8
.84	3	7.3	.84		4	3.2	.84		8	6.4
.85	3	6.4	.85		4	2.	.85		8	4.
.86	3	5.5	.86		4	0.9	.86		8	1.8
.87	3	4.6	.87		3	23.7	.87		7	23.5
.88	3	3.7	.88		3	22.7	.88		7	21.4
.89	3	2.9	.89		3	21.6	.89		7	19.2
.9	3	2.	.9		3	20.6	.9		7	17.2
.91	3	1.2	.91		3	19.5	.91		7	15.1
.92	3	0.4	.92		3	18.6	.92		7	13.2
.93	3	23.6	.93		3	17.5	.93		7	11.2
.94	2	23.	.94		3	16.6	.94		7	9.2
.95	2	22.1	.95		3	15.6	.95		7	7.3
.96	2	21.4	.96		3	14.8	.96		7	5.6
.97	2	20.7	.97		3	13.9	.97		7	3.8
.98	2	20.	.98		3	13.	.98		7	2.
.99	2	19.3	.99		3	12.1	.99		7	0.3

. The slabbing and roving tables rise progressively in 20th parts of a hank, as will be seen in the following tables. Thus 1, 1.05, or $1\frac{1}{20}$ and so on to 2 and 3 hank, &c.

What will 20 yards of $1\frac{1}{4}$, or 1.25 hank slabbing weigh?

Then 20 yards is $\frac{1}{6}$ of a lea, or 120 yards, which is equal to 166.66 grains of a 1 hank, as shown in a preceding table; which, divided by $1\frac{1}{4}$, or 1.25, will give the weight in grains that 20 yards should weigh.

Grains.
Hank slabbing, 1.25)166.66(133.33, or 5 dwts. $13\frac{3}{10}$ grs. weight, which will be found in the table opposite 1.25, and under 20 yards.
125
416
375
416
375
416
375
416
375
41

If 20 yards of slabbing weigh 5 dwts., 13.3 grains; what hank will it be?

5 dwts., 13.3 grains = 133.33)166.66(1.25, or $1\frac{1}{4}$ hank slabbing.
13333
33336
26666
66706
66666
40

SLABBING AND ROVING-TABLE.

From 1 hank to 2.95 hanks for 20, 30, 40, and 60 yards.

Hank roving.	20 yards.		30 yards.			40 yards.		60 yards.		
	dwts.	grains.	oz.	dwts.	grains.	dwts.	grains.	oz.	dwts.	grains.
1.	6	22.6		10	10.	13	21.3	1	2	14.5
1.05	6	14.7		9	22.	13	5.4	1	1	14.7
1.1	6	7.5		9	11.2	12	15.	1	0	17.
1.15	6	0.9		9	1.3	12	1.8		18	2.7
1.2	5	18.8		8	16.3	11	13.7		17	8.6
1.25	5	13.3		8	8.	11	2.6		16	16.
1.3	5	8.2		8	0.3	10	16.4		16	0.6
1.35	5	3.4		7	17.1	10	6.9		15	10.3
1.4	4	23.		7	10.5	9	22.		14	21.1
1.45	4	18.9		7	4.4	9	13.8		14	8.8
1.5	4	15.1		6	22.6	9	6.2		13	21.3
1.55	4	11.5		6	17.2	8	23.		13	10.5
1.6	4	8.1		6	12.2	8	16.3		13	0.5
1.65	4	5.1		6	7.6	8	10.2		12	15.
1.7	4	2.		6	3.	8	4.		12	6.1
1.75	3	23.9		5	22.8	7	22.4		11	21.7
1.8	3	20.6		5	18.8	7	17.1		11	13.7
1.85	3	18.		5	15.1	7	12.1		11	6.2
1.9	3	15.7		5	11.5	7	7.4		10	23.1
1.95	3	13.4		5	8.2	7	2.9		10	16.4
2.	3	11.3		5	5.	6	22.6		10	10.
2.05	3	9.3		5	1.9	6	18.6		10	3.8
2.1	3	7.3		4	23.	6	14.7		9	22.
2.15	3	5.5		4	20.2	6	11.		9	16.4
2.2	3	3.7		4	17.6	6	7.5		9	11.3
2.25	3	2.		4	15.1	6	4.1		9	6.2
2.3	3	0.4		4	12.6	6	0.9		9	1.3
2.35	2	22.9		4	10.3	5	21.8		8	10.6
2.4	2	21.4		4	8.1	5	18.8		8	16.2
2.45	2	20.		4	6.	5	16.		8	12.
2.5	2	18.6		4	4.	5	13.3		8	8.
2.55	2	17.3		4	2.	5	10.7		8	4.
2.6	2	16.1		4	0.1	5	8.2		8	0.3
2.65	2	14.9		3	22.3	5	5.7		7	20.6
2.7	2	13.7		3	20.6	5	3.4		7	17.2
2.75	2	12.6		3	18.9	5	1.2		7	13.8
2.8	2	11.5		3	17.2	4	23.		7	10.5
2.85	2	10.4		3	15.7	4	20.9		7	7.4
2.9	2	9.4		3	14.2	4	18.9		7	4.4
2.95	2	8.5		3	12.7	4	17.		7	1.5

What will 30 yards of $2\frac{9}{10}$ hank roving weigh?

250 is the dividend for 30 yards, which must be divided by the hank roving, and the quotient will be the weight in grains.

Hank roving, 2.9)250(86.2 grains, or 3 dwts., 14.2 grs., which
232 will be found in the table under 30
yards, and opposite 2.9 in the column of the hank roving.
180
174
60
58
2

If 40 yards weigh 4 dwts., 5 grains; what hank-roving will it be?

4 dwts., 5 grains, = 101 grs.)333.33(3.3, or $3\frac{3}{10}$ hank-roving.
303
303
303

What will 60 yards of $3\frac{3}{4}$, or 3.75 hank-roving weigh?

500 is the dividend for 60 yards.

Hank-roving $3\frac{3}{4}$, or 3.75)500.00(133.3, or 5 dwts., 13.3 grs.
375 weight of 60 yards of
a $3\frac{3}{4}$ hank-roving.
1250
1125
1250
1125
1250
1125
125

ROVING-TABLE.

From 3 hank, to 7.25 hanks, for 20, 30, 40, and 60 yards.

Hank roving.	20 yards.		30 yards.		40 yards.		60 yards.	
	dwts.	grains.	dwts.	grains.	dwts.	grains.	dwts.	grains.
3.	2	7.5	3	11.3	4	15.1	6	22.6
3.05	2	6.6	3	9.9	4	13.2	6	19.9
3.1	2	5.7	3	8.6	4	11.5	6	16.3
3.15	2	4.9	3	7.3	4	9.8	6	14.7
3.2	2	4.	3	6.1	4	8.1	6	12.2
3.25	2	3.2	3	4.9	4	6.5	6	9.8
3.3	2	2.5	3	3.7	4	5.	6	7.5
3.35	2	1.7	3	2.6	4	3.5	6	5.2
3.4	2	1.	3	1.5	4	2.	6	3.
3.45	2	0.3	3	0.4	4	0.6	6	0.9
3.5	1	23.6	2	23.4	3	22.2	5	22.8
3.55	1	22.9	2	22.4	3	21.9	5	20.8
3.6	1	22.3	2	21.4	3	20.6	5	18.8
3.65	1	21.6	2	20.5	3	19.3	5	16.9
3.7	1	21.	2	19.5	3	18.1	5	15.1
3.75	1	20.4	2	18.6	3	16.8	5	13.3
3.8	1	19.8	2	17.7	3	15.7	5	11.5
3.85	1	19.2	2	16.9	3	14.5	5	9.9
3.9	1	18.7	2	16.1	3	13.4	5	8.2
3.95	1	18.1	2	15.3	3	12.4	5	6.6
4.	1	17.6	2	14.5	3	11.3	5	5.
4.1	1	16.6	2	12.9	3	9.3	5	1.9
4.2	1	15.7	2	11.5	3	7.3	4	23.
4.3	1	14.7	2	10.1	3	5.5	4	20.2
4.4	1	13.8	2	8.8	3	3.7	4	17.6
4.5	1	13.	2	7.5	3	2.	4	15.1
4.6	1	12.2	2	6.3	3	0.4	4	12.7
4.7	1	11.4	2	5.2	2	22.9	4	10.4
4.8	1	10.7	2	4.1	2	21.4	4	8.1
4.9	1	10.	2	3.	2	20.	4	6.
5.	1	9.3	2	2.	2	18.6	4	4.
5.25	1	7.6	1	23.6	2	15.2	3	23.2
5.5	1	6.3	1	21.4	2	12.6	3	18.9
5.75	1	4.9	1	19.5	2	9.9	3	15.
6.	1	3.7	1	17.6	2	7.5	3	11.3
6.25	1	2.6	1	16.	2	5.3	3	8.
6.5	1	1.6	1	14.4	2	3.2	3	4.9
6.75	1	0.6	1	13.	2	1.3	3	2.
7.		23.8	1	11.7	1	23.6	2	23.4
7.25		22.9	1	10.4	1	21.9	2	20.9

CHANGE-PINIONS AT ROVING-FRAME.

By changing the driving-wheels, less pinions produce finer roving, by increasing the draught in rollers: driven-wheels decrease the hank-roving by reducing the draught in the rollers.

RULE.—Multiply the hank-roving by the number of teeth in the change-wheel, or pinion, and divide by the hank-roving you want, and the quotient will be the change-wheel, or pinion required.

If a 4 hank-roving requires a 24 teeth change-wheel, or pinion; what will a 4¾ hank require?

```
                             4 hank-roving.
                            24 teeth, change-wheel, or pinion.
                           ----
Hank-rov. required, 4.75)96.00(20.21, or 20 teeth, change-pinion,
                         9500          being a driving-wheel.
                         ----
                          1000
                           950
                          ----
                            500
                            475
                            ---
                             25
```

If a 4 hank-roving requires a 48 teeth (driven) change-wheel, or pinion; what will a 4¼ hank require?

```
                              4 hank-roving.
                             48 teeth, change-wheel.
                            ----
Hank-rov. required, 4.25)192.00(45.17, or 45 teeth, change-whl.
                         1700          or pinion required, being
                         ----          a driven-wheel.
                          2200
                          2125
                          ----
                            750
                            425
                           ----
                           3250
                           2975
                           ----
                            275
```

N. B.—It seldom occurs that a change-wheel can be had to produce exactly what is wanted.

ROVING-TABLE.

From 7.5 to 18.5 hanks for 30, 40, 60, and 120 yards.

Dec. of hank.	30 yards.		40 yards.		60 yards.			120 yards or 1 lea.		
	dwts.	grains.	dwts.	grains.	oz.	dwts.	grains.	oz.	dwts.	grains.
7.5	1	9.3	1	20.4		2	18.6		5	13.3
7.75	1	8.2	1	19.		2	16.5		5	9.
8.	1	7.2	1	17.6		2	14.5		5	5.
8.25	1	6.3	1	16.4		2	12.6		5	1.2
8.5	1	5.4	1	15.2		2	10.8		4	21.6
8.75	1	4.5	1	14.1		2	9.1		4	18.2
9.	1	3.7	1	13.		2	7.5		4	15.1
9.25	1	3.	1	12.		2	6.		4	12.
9.5	1	2.3	1	11.1		2	4.6		4	9.2
9.75	1	1.6	1	10.1		2	3.2		4	6.4
10.	1	1.	1	9.33		2	2.		4	4.
10.25	1	0.39	1	8.52		2	0.78		4	1.56
10.5		23.81	1	7.73		1	23.62		3	23.23
10.75		23.26	1	7.		1	22.52		3	21.04
11.		22.72	1	6.3		1	22.15		3	18.9
11.25		22.22	1	5.62		1	20.44		3	16.88
11.5		21.73	1	4.98		1	19.47		3	14.95
11.75		21.27	1	4.33		1	18.55		3	13.1
12.		20.83	1	3.77		1	17.66		3	11.33
12.25		20.4	1	3.2		1	16.81		3	9.6
12.5		20.	1	2.66		1	16.		3	8.
12.75		19.6	1	2.14		1	15.21		3	6.43
13.		19.23	1	1.64		1	14.46		3	4.92
13.25		18.86	1	1.16		1	13.73		3	3.47
13.5		18.51	1	0.69		1	13.03		3	2.07
13.75		18.18	1	0.24		1	12.36		3	0.72
14.		17.85		23.8		1	11.71		2	23.42
14.25		17.54		23.39		1	11.08		2	22.17
14.5		17.24		22.98		1	10.48		2	20.96
14.75		16.94		22.89		1	9.89		2	19.79
15.		16.66		22.22		1	9.33		2	18.66
15.25		16.39		21.85		1	8.78		2	17.57
15.5		16.12		21.52		1	8.25		2	16.57
15.75		15.87		21.16		1	7.74		2	15.49
16.		15.62		20.83		1	7.25		2	14.5
16.5		15.15		20.2		1	6.3		2	12.6
17.		14.7		19.6		1	5.41		2	10.82
17.5		14.28		19.05		1	4.57		2	9.14
18.		13.88		18.51		1	3.77		2	7.55
18.5		13.51		18.01		1	3.02		2	6.05

If 30 yards of roving, with a 24 teeth change-wheel, weigh 2 dwts., 14½ grains; what number of grains will the same length weigh with a 22 teeth change-wheel (driving)?

2 dwts., 14½ grs.,=62.5 grs., weight of 30 yds. with 24 tth. whl.
22 teeth change-wheel.

1250
1250

Chn. whl. 24 tth.)1375.0(57.29, or 2 dwts., 9¼ grains.
120

175
168

70
48

220
216

4

If 62½ grains of roving require a 24 teeth change-wheel, or pinion; what change-wheel, or pinion will there be required to produce a hank-roving the same length which will weigh 57¼ grains?

57.25 grains, weight required.
24 teeth, change-pinion, or wheel.

22900
11450

Given weight, 62.5 grs.)1374.00(22 teeth, nearly, change-wheel, or pinion required.
1250

1240
1250—nearly.

N. B.—When the number of grains which any given length weighs, is taken instead of the hank, multiply the grains by the change-wheel, or pinion you intend putting on, and divide by the change-wheel you have working, and the quotient will be the weight in grains required.

The following will be the dividends for any number of leas, from 1 to 7 leas, or 1 hank:—

N. B.—For as many leas that you weigh, take as many thousands for your dividend, as shown in the annexed table of dividends.

Leas.	Dividends.
1	1000
2	2000
3	3000
4	4000
5	5000
6	6000
7	7000

What will 2 leas of 22½ hank-roving, or yarn weigh?

Hank-roving, or yarn, 22.5)2000.0(88.888 grs, or 3 dwts. 16.88 grains.
1800
2000
1800
2000
1800
2000
1800
2000
1800
200

If 2 leas weigh 3 dwts., 17 grains; what hank will it be?

3 dwts., 17 grains = 89 grs.)2000(22.5, or 22½ hanks, nearly.
178
220
178
420
445—nearly.

ROVING AND YARN-TABLE.

From 19 to 33.5 hanks for 1, 2, 3, and 4 leas.

Hank roving.	1 lea.		2 leas.			3 leas.		4 leas.		
	dwts.	grains.	oz.	dwts.	grains.	dwts.	grains.	oz.	dwts.	grains.
19.	2	4.63		4	9.26	6	13.89		8	18.52
19.5	2	2.28		4	6.56	6	9.84		8	13.12
20.	2	2.		4	4.	6	6.		8	8.
20.5	2	0.78		4	1.56	6	2.34		8	3.12
21.	1	23.61		3	23.23	5	22.85		7	22.47
21.5	1	22.51		3	21.02	5	19.53		7	18.40
22.	1	21.45		3	18.9	5	16.36		7	13.81
22.5	1	20.44		3	16.88	5	13.33		7	9.77
23.	1	19.47		3	14.95	5	10.43		7	5.61
23.5	1	18.55		3	13.1	5	7.65		7	2.2
24.	1	17.66		3	11.33	5	5.		6	22.6
24.5	1	16.81		3	9.63	5	2.44		6	19.26
25.	1	16.		3	8.	5	0.		6	16.
25.5	1	15.21		3	6.43	4	21.64		6	12.86
26.	1	14.46		3	4.92	4	19.38		6	9.84
26.5	1	13.73		3	3.47	4	17.2		6	6.94
27.	1	13.03		3	2.07	4	15.11		6	4.14
27.5	1	12.36		3	0.72	4	13.09		6	1.44
28.	1	11.71		2	23.42	4	11.14		5	22.85
28.5	1	11.08		2	22.17	4	9.26		5	20.34
29.	1	10.48		2	20.96	4	7.44		5	17.93
29.5	1	9.89		2	19.79	4	5.69		5	15.58
30.	1	9.33		2	18.66	4	4.		5	13.33
30.5	1	8.78		2	17.57	4	2.36		5	11.14
31.	1	8.25		2	16.51	4	0.76		5	9.03
31.5	1	7.74		2	15.39	3	23.23		5	6.78
32.	1	7.22		2	14.5	3	21.75		5	5.
32.5	1	6.76		2	13.53	3	20.3		5	3.16
33.	1	6.3		2	12.6	3	18.9		5	1.21
33.5	1	5.85		2	11.7	3	17.55		4	23.4

* * *

For Yarn-Tables from No. 1 *to* 300, *and from* 1 *to* 7 *leas, and* 10 *hanks in length, see Tables published by* ROBERT SCOTT.

SELF-ACTING MULES.

The speed of the twist-shaft is required from the following particulars:—

Revolutions of lying-shaft a minute, 136.
Diameter of drum on shaft, 21 inches.
Diameter of pulley on counter-shaft, 14 inches.
Diameter of drum on counter-shaft, 16 inches.
Diameter of pulleys on twist-shaft, 12 inches.

```
    136 revolutions of lying-shaft a minute.
     21 inches, diameter of drum on lying-shaft.
   ----
    136
   272
   ----
   2856
     16 inches, diam. of drum on counter-shaft.
  -----
  17136
  2856
  -----
  45696 dividend.

     14 inches, diam. of pulley on counter-shaft.
     12 inches, diam. of pulleys on twist-shaft.
    ---
    168 divisor.

168)45696(272 revolutions of twist-shaft a min.
    336
    ----
    1209
    1176
    ----
      336
      336
```

N. B.—The self-acting mules from which these calculations are made, are spinning numbers 36's pin cops for power loom weaving.

The speed of the spindles is required from the following particulars:—

Revolutions of twist-shaft a minute, 272.
Diameter of grooved pulley on twist-shaft, $17\frac{3}{8}$ inches.
Diameter of grooved twist-pulley for driving vertical shaft, $10\frac{1}{4}$ inches.
Diameter of grooved pulley on vertical shaft, $10\frac{1}{4}$ inches.
Diameter of grooved pulley on tin drums, 10 inches.
Diameter of tin drums, driving spindles, 10 inches.
Diameter of spindle-wharves, $\frac{7}{8}$ inch.

N. B.—There are generally 3 *grooves in the band-pulley on the twist-shaft, the diameters of which are* $17\frac{3}{8}$, 18, *and* $18\frac{5}{8}$ *inches.*

When the driving and driven-pulleys, or drums, are alternately of the same dimensions as in the above question, they are omitted in the work.

272 revolutions of twist-shaft a minute.
17.375, or $17\frac{3}{8}$ inches, diameter of groove in pulley on twist-shaft.
1360
1904
816
1904
272
4726.000 dividend.

The divisor will be .875, which is equal to 7-8ths of an inch, the diameter of the spindle-wharves.

.875)4726.000(5401.1428 revolutions of spindles a minute.
4375
3510
3500
1000
875
1250
875
3750
3500
2500
1750
7500
7000
500

The speed of the vertical shaft is required from the following particulars:—

Revolutions of twist-shaft a minute, 272.
Diameter of groove in pulley on twist-shaft, 17⅜ inches.
Diameter of grooved twist-pulley for driving vertical-shaft, 10¼ inches.

```
           272 revolutions of twist-shaft a minute.
        17.375, or 17⅜ inches, diameter of groove in
        ------                  pulley on twist-shaft.
          1360
         1904
         816
       1904
       272
       -------
       4726.000 dividend.
```

The divisor will be 10.25, or 10¼ inches, the diameter of the grooved twist-pulley for driving vertical shaft.

```
10.25)4726.00(461.07317 revolutions of vertical shaft
      4100               a minute.
      ----
       6260
       6150
       -----
        1100
        1025
        -----
          7500
          7175
          -----
           3250
           3075
           -----
            1750
            1025
            -----
             7250
             7175
             ----
               75
```

N. B.—There is a 40 teeth-wheel on the grooved twist-pulley-shaft, which works into a 40 teeth-wheel on the foot of the vertical-shaft; but one being a driving and the other a driven-wheel, and each containing the same number of teeth, they are omitted in the above question and example.

The speed of the front rollers is required from the following particulars:—

Revolutions of twist-shaft a minute, 272.
Back pinion on twist-shaft, 18 teeth.
Back intermediate wheel, 42 teeth.
Back adjustable intermediate wheel, 70 teeth.
Back change-wheel on back-shaft, 50 teeth.
Wheel on back-shaft driving front rollers, 40 teeth.
Wheel on front rollers, connected with catch-box, 40 tth.

```
272 revolutions of twist-shaft a minute.
 18 teeth, back pinion on twist-shaft.
----
2176
272
----
4896 dividend.
```

The divisor will be 50, being the number of teeth in the change-wheel on the back-shaft. All the other wheels, with the exception of the back pinion on the twist-shaft, are omitted, on account of being connecting, or driving and driven-wheels containing the same number of teeth.

```
5.0)489.6
    -----
     97.92 revols. of front rollers a minute.
```

If the front rollers at the mules be 1 inch diameter, making 97.92 revolutions a minute; how many inches will they traverse?

```
      3.1416 circumference when the diameter is 1.
       97.92 revolutions of front rollers a minute.
      ------
       62832
      282744
     219912
    282744
    ----------
    307.625472 inches, front rollers traverse a minute.
```

The speed of the middle rollers is required from the following particulars:—

Revolutions of front rollers a minute, 97.92.
Wheel on the front rollers, 20 teeth.
Crown-wheel, 108 teeth.
Change-pinion, 24 teeth.
Wheel on the back rollers, 50 teeth.
Wheel on the end of back rollers, working into stud-wheel which drives middle rollers, 32 teeth.
Wheel on the middle rollers, 25 teeth.

97.92 revolutions of front rollers a minute.
20 teeth, wheel front rollers.

1958.40
24 teeth, change-pinion.

78336
39168

47001.6
32 teeth, wheel on the end of back rollers.

940032
1410048

1504051.2 dividend.

108 teeth, crown-wheel.
50 teeth, wheel on the back rollers.

5400
25 teeth, wheel on the middle rollers.

27000
10800

135000 divisor.

135.000 thus 5 × 9 × 3 = 135
5)1504.051.2
9)300.81024
3)33.42336

11.14112 revolutions of middle rollers a minute.

If the middle rollers be $\frac{3}{4}$ of an inch diameter, making 11.14112 revolutions a minute; how many inches will they traverse?

11.14112 revolutions of middle rollers a min.
.75 or $\frac{3}{4}$ inch diameter of middle rollers.

5570560
7798784

8.3558400
3.1416 circumference when the diameter is 1.

5013504
835584
3342336
835584
2506752

26.250706944, or rather more than $26\frac{1}{4}$ inches, middle rollers traverse a minute.

The speed of the back rollers is required from the following particulars:—

Revolutions of the front rollers a minute, 97.92.
Wheel on the front rollers, 20 teeth.
Crown-wheel, 108 teeth.
Change-pinion, 24 teeth.
Wheel on the back rollers, 50 teeth.

97.92 revolutions of front rollers a minute.
20 teeth, wheel on front rollers.

1958.40
24 teeth, change-pinion.

78336
39168

47001.6 dividend.
108 teeth, crown wheel.
50 teeth, wheel on the back rollers.

54.00 divisor, or 9)470.01.6
9 × 6 = 54 6)52.224

8.704 revolutions of back rollers a minute.

If the back rollers be $\frac{7}{8}$ths of an inch diameter, making 8.704 revolutions a minute; how many inches will they traverse?

8.704 revolutions of back rollers a minute.
.875, or $\frac{7}{8}$ths of an inch, diam. of rollers.

43520
60928
69632

7.616000
3.1416 circumference when the diameter is 1.

45696
7616
30464
7616
22848

23.9264256, or nearly 24 inches, back rollers traverse a minute.

The draught between the middle and back rollers is required from the following particulars:—

Middle rollers traverse 26.250706944 inches a minute.
Back rollers traverse 23.9264256 inches a minute.

23.9264256)26.250706944(1.0971428, or nearly $1\frac{1}{10}$ draught between the mid. and back rols.
239264256

2324281344
2153378304

1709030400
1674849792

341806080
239264256

1025418240
957057024

683612160
478528512

2050836480
1914114048

136722432

The draught between the front and middle rollers is required from the following particulars:—

Front rollers traverse 307.625472 inches a minute.
Middle rollers traverse 26.250706944 inches a minute.

26.250706944)307.62547200(11.71875 draught between the front and mid. rollers.
26250706944

45118402560
26250706944

188676956160
183754948608

49220075520
26250706944

229693685760
210005655552

196880302080
183754948608

131253534720
131253534720

The draught between the front and back rollers is required from the following particulars:—

Front rollers traverse 307.625472 inches a minute.
Back rollers traverse 23.9264256 inches a minute.

23.9264256)307.625472(12.857 draught between the front and back rollers.
239264256

683612160
478528512

2050836480
1914114048

1367224320
1196321280

1709030400
1674849792

34180608

The draught between the front and back rollers is required from the following particulars:—

Draught between the front and middle rollers, 11.71875.

Draught between the middle and back rollers, 1.09714.

$$\begin{array}{rl}
11.71875 & \text{draught between front and mid. rols.} \\
1.09714 & \text{draught between middle and back rols.} \\
\hline
4687500 & \\
1171875 & \\
8203125 & \\
10546875 & \\
11718750 & \\
\hline
12.8571093750 & \text{draught between the front and back rollers.}
\end{array}$$

The draught between the front and middle rollers is required from the following particulars:—

Wheel on front rollers, 20 teeth.

Crown-wheel, 108 teeth.

Change-pinion, 24 teeth.

Wheel on back rollers, 50 teeth.

Wheel on the end of back rollers, working a stud-wheel which drives the middle rollers, 32 teeth.

Wheel on middle rollers, 25 teeth.

Diameter of front rollers, 1 inch or $\frac{8}{8}$ths.

Diameter of middle rollers, $\frac{3}{4}$ inch, or $\frac{6}{8}$ths.

DRIVING-WHEELS.

$$\begin{array}{rl}
20 & \text{teeth, wheel on front rollers.} \\
24 & \text{teeth, change-pinion.} \\
\hline
480 & \\
32 & \text{teeth, wheel on the end of back rollers.} \\
\hline
960 & \\
1440 & \\
\hline
15360 & \\
\frac{6}{8} & \text{ths, or } \frac{3}{4} \text{ inch diameter of middle rollers.} \\
\hline
92160 & \text{divisor.}
\end{array}$$

DRIVEN-WHEELS.

108 teeth, crown wheel.
50 teeth, wheel on back rollers.

5400
25 teeth, wheel on middle rollers.

27000
10800

135000
$\frac{8}{8}$ths, or 1 inch, diameter of front rols.

1080000 dividend.

92160)1080000(11.71875 draught between the front and middle rollers.
92160

158400
92160

662400
645120

172800
92160

806400
737280

691200
645120

460800
460800

The draught between the front and back rollers is required from the following particulars:—

Wheel on front rollers, 20 teeth.
Crown-wheel, 108 teeth.
Change-pinion, 24 teeth.
Wheel on back rollers, 50 teeth.

Diameter of front rollers, 1 inch, or $\frac{8}{8}$ths.
Diameter of back rollers, $\frac{7}{8}$ inch, or $\frac{7}{8}$ths.

DRIVING-WHEELS.

20 teeth, wheel on front rollers.
24 teeth, change-pinion.

480
$\frac{7}{8}$ths, or $\frac{7}{8}$ inch, diam. of back rollers.

3360 divisor.

DRIVEN-WHEELS.

108 teeth, crown-wheel.
50 teeth, wheel on back rollers.

5400
$\frac{8}{8}$ths, or 1 inch, diameter of front rollers.

43200 dividend.

3360)43200(12.8571 draught between the front and back rollers.
3360

9600
6720

28800
26880

19200
16800

24000
23520

4800
3360

1440

N. B.—By examining the different systems of working draughts as shown in the last examples, it will be found that they all agree with each other; therefore, any of the systems may be adopted.

The speed of the long drawing-out shaft is required from the following particulars:—

Revolutions of twist-shaft a minute, 272.
Back pinion on twist-shaft, 18 teeth.
[*] Back intermediate wheel, 42 teeth.
[*] Back adjustable intermediate wheel, 70 teeth.
Back change-wheel on back shaft driving front rols. 50 teeth.
Wheel on back shaft, 19 teeth.
Back change-wheel on long drawing-out shaft, 61 teeth.

272 revolutions of twist-shaft a minute.
18 teeth, back pinion on twist-shaft.

2176
272

4896
19 teeth, wheel on back shaft.

44064
4896

93024 dividend.

50 teeth, change-wheel on back shaft, for driving front rols.
61 teeth, back change-wheel on long drawing-out shaft.

3050 divisor.

3050)93024(30.499, or nearly 30½ revolutions of long drawing-out shaft a min.
9150

15240
12200

30400
27450

29500
27450

2050

---

[*] These are only carrying or connecting-wheels; consequently, they are omitted in the work.

The speed of the drawing-out scroll-shaft is required from the following particulars:—

Revolutions of long drawing-out shaft a minute, 30.5.
Bevil-wheel on long drawing-out shaft, 24 teeth.
Bevil-wheel on scroll-shaft, 48 teeth.

```
                       30.5 revols. of long drawing-out shaft a min.
                         24 teeth, bevil-wheel on drawing-out shaft.
                       ----
                       1220
                       610
Teeth of bev. \        -----
wl. on scroll- > 48)732.0(15.25 revolutions of drawing-out scroll-
shaft,        /        48             shaft a minute.
                       ----
                       252
                       240
                       ----
                        120
                         96
                        ----
                         240
                         240
```

The speed of the drawing-out scroll-shaft is required from the following particulars:—

Revolutions of twist-shaft a minute, 272.
Back pinion on twist-shaft, 18 teeth.
Back change-wheel on back shaft, for driving front rollers, 50 teeth.
Wheel on back shaft, 19 teeth.
Back change-wheel on long drawing-out shaft, 61 teeth.
Bevil-wheel on long drawing-out shaft, 24 teeth.
Wheel on drawing-out scroll-shaft, 48 teeth.

```
                 272 revolutions of twist-shaft a minute.
                  18 teeth, back pinion on twist-shaft.
                ----
                2176
                272
                ----
                4896
                  19 teeth, wheel on back shaft.
              ------
               44064
               4896
              ------
               93024
                  24 teeth, bevil-wheel on long drawing-out shaft.
              ------
              372096
             186048
             -------
             2232576 dividend.

     50 teeth, back change-whl. on back shaft, for driv. front rols.
     61 teeth, back change-wheel on long drawing-out shaft.
   ----
   3050
     48 teeth, bevil-wheel on drawing-out scroll-shaft.
  -----
  24400
 12200
 ------
 146400 divisor.

               146400)2232576(15.25, or 15¼ revolutions nearly,
                      146400          drawing-out scroll a min.
                      ------
                       768576
                       732000
                       -------
                        365760
                        292800
                        -------
                         729600
                         732000—nearly.
```

If the drawing-out scroll be $6\frac{3}{4}$ inches diameter, making $15\frac{1}{4}$ revolutions a minute; how many inches will the scroll, or carriage traverse?

15.25, or $15\frac{1}{4}$ revolutions of scroll a minute.
6.75, or $6\frac{3}{4}$ inches, diameter of scroll.

7625
10675
9150

102.9375
3.1416 circumference when the diameter is 1.

6176250
1029375
4117500
1029375
3088125

323.38845000, or nearly $323\frac{4}{10}$ inches, drawing-out scroll traverses a minute.

The length delivered by the front rollers a stretch is required from the following particulars:—

Carriage, or drawing-out scroll traverses 323.38845 inches a minute.
Front rollers traverse 307.625472 inches a minute.
Length of stretch put up, 60.5, or $60\frac{1}{2}$ inches.

307.625472 inches front rollers traverse a min.
60.5, or $60\frac{1}{2}$ inches length of stretch.

1538127360
18457528320

18611.3410560 dividend.

Car. travs. a min. 323.38845 in.)18611.3410560(57.551 in., front
161694225 rollers deliver a
stretch.

244191855
226371915

178199406
161694225

165051810
161694225

33575850
32338845

1237005

If the length delivered at the front rollers a stretch, be 57.551 inches, and the length of the stretch put up, be 60.5, or 60½ inches; how many inches a stretch does the carriage gain?

60.500, or 60½ inches, length of stretch put up.
57.551 inches, length deliv. at front rols. a stretch.

2.949, or nearly 3 inches gain of carriage.

The draught between the carriage and front rollers is required from the following particulars:—

Carriage traverses 323.38845 inches a minute.
Front rollers traverse 307.625472 inches a minute.

307.625472)323.388450(1.05124 draught between carriage
307625472 and front rollers.

1576297800
1538127360

381704400
307625472

740789280
615250944

1255383360
1230501888

24881472

The length of the stretch is required from the following particulars:—

Front rollers deliver 57.551 inches a minute.
Draught between carriage and front rollers, 1.05124.

57.551 inches, front rollers deliver a minute.
1.05124 draught between carriage and front rollers.

230204
115102
57551
287755
576510

60.49991324, or 60½ inches, length of stretch.

The total draught at mules is required from the following particulars:—

Draught between front and back rollers, 12.857109375.
Draught between carriage and front rollers, 1.05124.

12.857109375 draught between front and back rols.
1.05124 draught between car. and front rols.

51428437500
25714218750
12857109375
64285546875
128571093750

13.51590765937500, or rather more than 13½ total draught at mules.

The total draught at mules is required from the following particulars:—

Revolutions of drawing-out scroll a minute, 15.25.
Revolutions of back rollers a minute, 8.704.
Diameter of scroll, 6¾ inches, or 54-8ths.
Diameter of back rollers, ⅞ inches, or 7-8ths.

15.25 revolutions of drawing-out scroll a min.
54-8ths, or 6¾ inches, diameter of drawing-out scroll.

6100
7625

823.50 dividend.

8.704 revolutions of back rollers a minute.
7-8ths, or $\frac{7}{8}$ inch, diameter of back rollers.

60.928 divisor.

Divisor. Dividend.
60.228)823.500(13.515 total draught at mules.
60928

214220
182784

314360
304640

97200
60928

362720
304640

58080

The total draught at mules is required from the following particulars:—

Bevil-wheel on drawing-out scroll-shaft, 48 teeth.
*Bevil-wheel on long drawing-out shaft, 24 teeth.
Back change-wheel on drawing-out shaft, 61 teeth.
Wheel on back shaft, 19 teeth.
Wheel on front rollers, 20 teeth.
Crown-wheel, 108 teeth.
*Change-pinion, 24 teeth.
Wheel on back rollers, 50 teeth.
Diameter of drawing-out scroll, $6\frac{3}{4}$ inches, or 54-8ths.
Diameter of back rollers, $\frac{7}{8}$ inch, or 7-8ths.

---

* These wheels are omitted in working, one being a driving and the other a driven-wheel, each containing the same number of teeth.

DRIVING-WHEELS.

48 teeth, bevil-wheel on drawing-out scroll-shaft.
61 teeth back change-wheel on drawing-out shaft.

48
288

2928
20 teeth, wheel on front rollers.

58560
7-8ths inch, diameter of back rollers.

409920 divisor.

DRIVEN-WHEELS.

19 teeth, wheel on back shaft.
108 teeth, crown-wheel.

152
190

2052
50 teeth, wheel on back rollers.

102600
54-8ths, or 6¾ in. diam. of drawing-out scroll.

410400
513000

5540400 dividend.

409920)5540400(13.5158 total draught at mules.
409920

1441200
1229760

2114400
2049600

648000
409920

2380800
2049600

3312000
3279360

32640

N. B.—By changing the 50 *teeth wheel on the back shaft, it will affect the front rollers and drawing-out scroll in the same proportion; consequently, the gain, or draught at carriage, will remain the same. The gain, or draught at carriage, may be altered by changing the* 61 *teeth wheel on the long drawing-out shaft; both being driven-wheels from the first moving power, a less number of teeth will increase the speed, whereas, had they been driving-wheels, it would have required a greater number of teeth to have produced an increase of speed, and the reverse for a decrease in speed.*

The speed of the quadrant-shaft is required from the following particulars:—

Revolutions of drawing-out scroll a minute, 15.25.
Diameter of scroll, 6.75 inches.
Diameter of drum on quadrant-shaft, 6.125.

15.25 revols. of drawing-out scroll a minute.
6.75, or $6\frac{3}{4}$ inches, diameter of scroll.

7625
10675
9150

102.9375

Diam. of drum on quad.-shaft, 6.125 in.)102.9375(16.806 revols. of quad.-shaft a min.
6125

41687
36750

49375
49000

37500
36750

750

N. B.—The quadrant-shaft is driven by the drawing-out scroll band while the carriage is drawing out, and the chain on the winding-on drum is counterbalanced by a weight at the end of a band working on pulleys and connected with the winding-on *drum, which is out of geer while drawing out, and is put into geer by a spring connected with the long lever and vertical shaft when the carriage is going in; during which time, the speed of the winding-on drum is governed by a strap working the governor-wheels connected with the worm, when the slide to which the winding-on chain is affixed rises in the recess of the quadrant by means of the worm, and decreases the length of the chain from the drum, regulating the winding on according to the increasing thickness of the cop. When the cop has attained the intended thickness, then the governor-wheels cease to work, and the length of the chain going on the winding-on drum remains the same till the cop is completed.*

The number of teeth the quadrant moves a stretch is required from the following particulars:—

Carriage traverses 323.38845 inches a minute.
Revolutions of quadrant-shaft a minute, 16.806.
Wheel on quadrant-shaft, 22 teeth.
Length of stretch, 60½ inches.

16.806 revols. of quad.-shaft a min.
22 teeth, wheel on quad.-shaft.

33612
33612

369.732
60.5, or 60½ in., length of stretch.

1848660
22183920

Car. travs., 323.38845 in.)22368.7860(69.17 num. of teeth quad. moves a stretch of 60½ inches.
194033070

296547900
291049605

54982950
32338845

226441050
226371915

69135

The turns an inch of yarn are required from the following particulars :—

Bell-wheel worked by a worm on the twist-shaft, 56 teeth.
Diameter of the grooved pulley on the twist-shaft, 17⅜ inches.
Diameter of grooved twist-pulley, driving vertical shaft, 10¼ inches.
* Diameter of grooved pulley on the vertical shaft, 10¼ inches.
Diameter of grooved pulley on tin drums, 10 inches.
Diameter of tin drums, driving the spindles, 10 inches.
Diameter of wharves on the spindles, ⅞ inch.
Length of stretch put up, 60½ inches.

17.375, or 17⅜ inches, diam. of grooved pul. on [the twist-shaft.
56 teeth, bell-wheel.

104250
86875

973.000 dividend.

.875, or ⅞ths of an inch, diam. of wharves.
60.5, or 60½ inches, length of stretch.

4375
52500

52.9375 divisor.

52.9375)973.0000(18.38 turns an inch of yarn required.
529375

4436250
4235000

2012500
1588125

4243750
4235000

8750

---

* These are all omitted in the work, being driving and driven, of the same dimensions.

The number of teeth in the bell-wheel is required from the following particulars:—

Number of turns an inch of yarn required, 18.38.
Length of stretch put up, 60.5 inches.
Diameter of wharves on the spindles, $\frac{7}{8}$ inch.
*Diameter of drum driving wharves, 10 inches.
Diameter of pulley on drum driving wharves, 10 inches.
Diameter of pulley on vertical shaft, $10\frac{1}{4}$ inches.
Diameter of pulley driving vertical shaft, $10\frac{1}{4}$ inches.
Diameter of pulley on twist-shaft, $17\frac{3}{8}$ inches.

18.38 turns an inch.
60.5 inches, length of stretch.

9190
110280

1111.990, or 1112 turns in a st'ch of $60\frac{1}{2}$ in.
.875, or $\frac{7}{8}$ inch, diam. of spindle wharves.

555995
778393
889592

In. diam. of pul. on twist-s'ft, 17.375)972.99125(56 nearly, number of teeth required in the bell-wheel.
86875

104241
104250—nearly.

N. B.—All the rules are fully laid down in a former part of this work. (See *Hand Mules.*)

The speed of the short going-in shaft is required from the following particulars:—

Revolutions of twist-shaft a minute, 272.
Wheel on loose pulley, 36 teeth.
Wheel on short going-in shaft, 54 teeth.

---

* These are omitted in the work on account of being driving and driven of the same dimensions; but if the diameters had been of different dimensions, they must have been made use of as in former examples.

272 revolutions of twist-shaft a minute.
36 teeth, wheel on loose pulley.

1632
816

Teeth of wheel on short going-in shaft, } 54)9792(181.33, or $181\frac{1}{3}$ revolutions of short going-in shaft a minute.
54

439
432

72
54

180
162

180
162

18

The speed of the long going-in shaft is required from the following particulars:—

Revolutions of twist-shaft a minute, 272.
Wheel on loose pulley, 36 teeth.
Wheel on short going-in shaft, 54 teeth.
Wheel on short going-in shaft, 17 teeth.
Wheel on long going-in shaft, 20 teeth.

272 revolutions of twist-shaft a minute.
36 teeth, wheel on loose pulley.

1632
816

9792
17 teeth, wheel on short going-in shaft.

68544
9792

166464 dividend.

54 teeth, wheel on short going-in shaft.
20 teeth, wheel on long going-in shaft.

1080 divisor.

1080)166464(154.133 revolutions of long going-in
1080 shaft a minute.

5846
5400

4464
4320

1440
1080

3600
3240

3600
3240

360

The speed of the going-in scroll-shaft is required from the following particulars:—

Revolutions of twist-shaft a minute, 272.
Wheel on loose pulley, 36 teeth.
Wheel on short going-in shaft, 54 teeth.
Wheel on short going-in shaft, 17 teeth.
Wheel on long going-in shaft, 20 teeth.
Bevil-wheel on long going-in shaft, 16 teeth.
Bevil-wheel on scroll-shaft, 45 teeth.

272 revolutions of twist-shaft a minute.
36 teeth, wheel on loose pulley.

1632
816

9792

9792
17 teeth, wheel on short going-in shaft.

68544
9792

166464
16 teeth, bevil-wheel on long going-in shaft.

998784
166464

2663424 dividend.

54 teeth, wheel on short going-in shaft.
20 teeth, wheel on long going-in shaft.

1080
45 teeth, bevil-wheel on scroll-shaft.

5400
4320

48600 divisor.

48600)2663424(54.80296 revolutions of going-in scroll a minute.
243000

230424
194400

390240
388800

144000
97200

468000
437400

306000
291600

14400

The revolutions of the going-in scroll a stretch, are required from the following particulars:—

Circumference, or chase of scroll a stretch, 22 inches.
Length of stretch put up, $60\frac{1}{2}$ inches.

22)60.5(2.75, or $2\frac{3}{4}$ revolutions of going-in
44 scroll a stretch.
165
154
110
110

The speed of the backing-off wheel is required from the following particulars:—

Revolutions of long going-in shaft a minute, 154.133.
Wheel on long going-in shaft, 12 teeth.
Backing-off wheel, 77 teeth.

154.133 revols. of long going-in shaft a min.
12 teeth, wheel on long going-in shaft.
Teeth of backing-off wheel, 77)1849.600(24.02 revols. of backing-off wheel
154 a minute.
309
308
160
154
6

N. B.—The backing-off wheel can be regulated by the leather friction pulley, which works into the backing-off wheel, and may be made slacker, or tighter, by means of a bolt and nut connected with the friction pulley. The proper friction on the backing-off wheel is very essential, which will soon be ascertained by any practical person.

Required, from the following particulars, the length of time a stretch the carriage occupies while going in.

Revolutions of going-in scroll a minute, 54.80296.
Revolutions of going-in scroll a stretch, 2.75.

```
                                   2.75 revols. of going-in scroll a
                                      60 seconds, 1 min.  [stretch.
                                   ----------
Revols. of going-in } 54.80296)165.00000(3.010786,  or  rather
scroll a minute,    }          16440888             more than
                               ----------           3  seconds
                                  5911200           a stretch.
                                  5480296
                                  ----------
                                   43090400
                                   38362072
                                   ----------
                                    47283280
                                    43842368
                                    ----------
                                     34409120
                                     32881776
                                     ----------
                                      1527344
```

If it requires 56 turns or revolutions of the twist-shaft to draw out one stretch, what time will it require, if the twist-shaft makes 272 turns or revolutions a minute?

```
272)56.0(.20588 minute a stretch.
     544
     -----
      1600
      1360
      -----
       2400
       2176
       -----
        2240
        2176
        -----
          64

  .20588 minute a stretch.
       60 seconds, 1 minute.
  ----------
  12.35280 seconds required to draw out 1
                                  stretch.
```

The number of stretches a mule a minute is required from the following particulars, allowing $2\frac{1}{2}$ seconds a stretch for backing off.

Drawing out a stretch,	12.3528	seconds.
Backing off a stretch,	2.5	seconds.
Going in a stretch,	3.0107	seconds.
	17.8635	seconds a stretch.

17.8635)60.0000(3.3588, or rather more than $3\frac{7}{20}$ stretches a minute, each mule.
535905

640950
535905

1050450
893175

1572750
1429080

1436700
1429080

7620

If a mule produce 3.3588 stretches a minute, and each stretch be 60 inches, how many hanks a spindle will be produced in one week, allowing them to work successively for 65 hours?

3.3588 stretches a minute.
60 minutes, 1 hour.

201.5280 stretches an hour.
65 hours in 1 week.

1007640
1209168

13099.320 stretches in 1 week.
60 inches each stretch.

785959.200 inches of yarn a spindle a week.

```
1 yard is  } 6)785959.2 inches of yarn a spindle a week.
36 inches, }   --------
             6)130993.2
               --------
                21832.2 yards a spindle a week.
               --------
1 hank is 840 yds.)21832.2(25.99 nearly 26 hanks a spindle a
                   1680                                 week.
                   ----
                    5032
                    4200
                    ----
                     8322
                     7560
                     ----
                      7620
                      7560
                      ----
                        60
```

The speed of the leather-contact pulley is required from the following particulars:—

Revolutions of twist-shaft a minute, 272.
Wheel on loose pulley, 36 teeth.
Wheel on leather-contact pulley shaft, 33 teeth.

```
                          272 revolutions of twist-pulley a min.
                           36 teeth, wheel on loose pulley.
                         ----
                         1632
                         816
Teeth-wheel on     }     ----
leather-contact    } 33)9792(296.727 revols. of leather-contact
pulley,            }     66                  pulley a minute.
                         ---
                         319
                         297
                         ---
                          222          90
                          198          66
                          ---          ---
                           240         240
                           231         231
                           ---         ---
                            90           9
```

If the leather-contact pulley be 3¾ inches diameter, making 296.727 revolutions a minute, what will it traverse?

296.727 revols. of leather-contact pulley a min.
3.75, or 3¾ inches, diameter of do.

1483635
2077089
890181

1112.72625
3.1416 circumference when the diameter is 1.

667635750
111272625
445090500
111272625
333817875

3495.740787000 inches leather-contact pulley traverses a minute.

The revolutions of the spindles for the twist-shaft once are required from the following particulars:—

Revolutions of spindles a stretch, 1112.
Revolutions of twist-shaft a stretch, 56.

Revols. of twist-shaft a stretch is 56, then 8 × 7=56, } 8)1112 revols. of spindles a stretch.

7)139

19.857 revols. of the spindles for the twist-shaft once.

Required, from the following particulars, the revolutions a stretch of the spindles for winding on yarn at the beginning of the set—*i. e.*, when the spindles are bare:—

Diameter of winding-on drum, 4⅛ or 4.125 inches.
Length of chain thrown off drum, 60½ or 60.5 inches.
Wheel on the winding-on drum, 41 teeth.
Pinion on winding-on drum-shaft, 25 teeth.

* Bevil-wheel on winding-on drum-shaft, 40 teeth.
Bevil-wheel on foot of vertical shaft, 40 teeth.
Diameter of pulley on vertical shaft, 10¼ or 10.25 inches.
Diameter of spindle-wharves, ⅞ or .875 inch.
4.125 inches, diameter of winding-on drum.
3.1416 inches, circum. when the diam. is 1.

24750
4125
16500
4125
12375

12.9591000
25 teeth, pinion on winding-on drum-shaft.

647955
259182

323.9775
.875 inches, diameter of wharves.

16198875
22678425
25918200

283.4803125 divisor.

60.5 in., length of chn. thrown off wind.-on drum.
41 teeth, wheel on winding-on drum.

605
2420

2480.5
10.25 inches diam. of pulley on vertical shaft.

124025
49610
248050

25425.1250000

---

* These are omitted in the work, being driving and driven; and the tin drums for driving spindles are omitted, being intermediate.

```
283.4803125)25425.1250000(89.689 revols. of spindle a stretch,
            22678425000           winding yarn on bare spin-
            -----------           dles.
             27467000000
             25513228125
             -----------
              19537718750
              17008818750
              -----------
               25289000000
               22678425000
               -----------
                26105750000
                25513228125
                -----------
                  592521875
```

If it requires the bare or empty spindles to make 89.689 revolutions to wind on a stretch 60½ inches long; what will the circumference and diameter of the spindles be?

```
89.689)60.5000(.67455 inch, circumference of spindles.
       538134
       ------
        668660
        627823
        ------
         408370
         358756
         ------
          496140
          448445
          ------
           476950
           448445
           ------
            28505
```

3.1416).67455(.2147 inch, diameter of spindles.
62832
46230
31416
148140
125664
224760
219912
4848

The speed of the spindles for winding on the yarn will be in accordance with their diameter, from which may be ascertained the size of the winding-on drum, or pinion on the winding-on drum-shaft.

If the diameter of the spindles be ¼ inch; how many revolutions must they make to wind on 60½ inches of yarn?

3.1416 circumference when the diameter is 1.
.25, or ¼ inch, diameter of spindles.
157080
62832
.785400 circumference of spindle.

.7854)60.5000(77 revolutions required for spindle, to wind on 60½ inches of yarn.
54978
55220
54978
242

Required, the revolutions of the winding-on drum, for the spindles to make 77 revolutions, or turns a stretch, according to the following particulars:—

Diameter of spindle wharves, ⅞, or .875 inch.
Diameter of pulley on vertical shaft, 10¼ inches.

Pinion on winding-on drum-shaft, 25 teeth.
Wheel on winding-on drum, 41 teeth.

.875 diameter of spindle-wharves.
77 revols., or turns of spindles a stretch.
6125
6125
67.375
25 teeth, pinion on winding-on drum-shaft.
336875
134750
1684.375 dividend.

10.25 inches, diameter of pulley on vertical shaft.
41 teeth, wheel on winding-on drum.
1025
4100
420.25 divisor.

420.25)1684.375(4 revolutions of winding-on drum
168100 a stretch required.
337

If the winding-on drum be required to make 4 revolutions a stretch; what must the circumference be to wind on 60½ inches of chain?

4)60.5
15.125, or 15⅛ inches, circumference of drum.

If the winding-on drum be 15.125, or 15⅛ inches circumference; what will the diameter be?

```
3.1416)15.1250(4.8144 inches, diameter of winding-
       125664         on drum.
       ------
        255860
        251328
        ------
          45320
          31416
          -----
          139040
          125664
          ------
           133760
           125664
           ------
             8096
```

The iron-contact pulley on the cam-shaft is 5$\frac{1}{16}$ inches diameter, and has 4 recesses, or spaces in it at an equal distance, which relieve it from the leather-contact pulley, and is also assisted by 4 pins in the front of the escape-plate, each of which works against a spring, when the spring at the back of the escape-plate moves from one bolster to another when acted upon by the lever connected, and which gives power, by the assistance of the leather-contact pulley, to the different motions on the cam-shaft, which is as follows:—

Motions from the escape-plate.
First—Back and front cams for the strap-lever.
Second—Backing-off cam connected with the friction-pulley, working into backing-off wheel-pulley.
Third—Front roller eccentric.
Fourth—Stop-finger connected with the bell-wheel-shaft.
Fifth—Going-in eccentric.
Sixth—Drawing-out eccentric.

The following are the alternate movements on the cam-shaft each stretch:—
First—Roller geer and drawing-out motions.
Second—Twist motion.
Third—Backing-off motion.
Fourth—Going-in motion.

THE FOLLOWING ARE THE PARTICULARS OF THE SELF-ACTING MULES:—

Revolutions of twist-shaft a minute, 272.
Revolutions of spindles a minute, 5401.1428.
Revolutions of vertical shaft a minute, 461.07317.
Revolutions of front rollers a minute, 97.92.
Revolutions of middle rollers a minute, 11.14112.
Revolutions of back rollers a minute, 8.704.
Revolutions of long drawing-out shaft a minute, 30.499 or 30½.
Revolutions of drawing-out scroll a minute, 15.249 or 15¼.
Revolutions of quadrant-shaft a minute, 16.806.
Revolutions of short going-in shaft a minute, 181.333.
Revolutions of long going-in shaft a minute, 154.1333.
Revolutions of going-in scroll a minute, 54.80296.
Revolutions of going-in scroll a stretch, 2.75 or 2¾.
Revolutions of backing-off wheel a minute, 24.02.
Revolutions of leather-contact pulley a minute, 296.727.
Revolutions of spindles per twist-shaft once, 19.857.
Revolutions of bare or empty spindles for winding on yarn a stretch, at the beginning of set, 89.689.
Diameter of pulleys on twist-shaft, 12 inches.
Diameter of grooved band-pulley on twist-shaft, 17⅜, 8, and 18⅝ inches.
Diameter of grooved twist-pulley for driving vertical shaft, 10¼ inches.
Diameter of grooved pulley on vertical shaft, 10¼ inches.
Diameter of grooved pulley on tin drums, 10 inches.
Diameter of tin drums for driving spindles, 10 inches.
Diameter of spindle-wharves, ⅞ inch.
Diameter of front rollers, 1 inch.
Diameter of middle rollers, ¾ inch.
Diameter of back rollers, ⅞ inch.
Diameter of drawing-out scroll, 6¾ inches.
Diameter of quadrant-shaft drum, 6⅛ inches.
Diameter of leather-contact pulley, 3¾ inches.
Diameter of iron-contact pulley, $5\frac{1}{16}$ inches.
Diameter of winding-on drum, 4⅛ inches.
Diameter of spindles, .2147 inch.
Front rollers traverse a minute, 307.625472 inches.
Middle rollers traverse a minute, 26.250707 inches.
Back rollers traverse a minute, 23.926425 inches.
Drawing-out scroll traverses a minute, 323.38845 inches.

Front rollers traverse a stretch, 57.551 inches.
Carriage traverses a stretch, 60.5 inches.
Going-in scroll traverses a revolution, 22 inches.
Leather-contact pulley traverses a minute, 3495.749787 inches.
Draught between the middle and back rollers, 1.0971428, nearly $1\frac{1}{10}$.
Draught between the front and middle rollers, 11.71875.
Draught between the front and back rollers, 12.8571.
Draught between the front rollers and carriage, 1.05124.
Total draught at the mules, 13.5158.
Gain at carriage each stretch, 2.949, nearly 3 inches..
Turns each inch in yarn, 18.38.
Turns each stretch of $60\frac{1}{2}$ inches, 1112.
Bell-wheel, 56 teeth.
Number of teeth the quadrant moves each stretch of $60\frac{1}{2}$ inches, 69.17.
Time each stretch drawing carriage out, 12.3528 seconds.
Time each stretch allowed for backing off, 2.5 seconds.
Time each stretch carriage going in, 3.0107 seconds.
Time required to complete each stretch, 17.8635 seconds.
Number of stretches a minute, each mule, 3.3588.
Number of stretches an hour, each mule, 201.528.
Number of stretches a week, each mule, 13099.32.
Number of hanks a spindle a week, 25.99, or 26 hanks nearly.

The faller rises by the lowering of the coping-rail, by means of a lever connected with the faller-sector working upon it. The faller-sector at the same time works into a 22 teeth-wheel on the faller-shaft.

The backing-off eccentric is loose on the vertical shaft; and the chain attached to the eccentric and connected with the faller-sector is governed by a catch fixed to the plate of the eccentric, working against the ratchet-wheel while backing off.

N. B.—The number of teeth in the ratchet-wheel is 88.

At the commencement of a set, when the spindles are bare or empty, great care must be taken to set the coping-rail and winding-on chain to their proper places, by means of the worm or screw connected; for, if right, then they will regulate themselves afterwards.

Whatever bevil the coping-rail may have will be the length of the chase given to the faller, which may be increased or decreased by giving more bevil to the coping-rail, and by changing the wheel on the worm-shaft connected with the shaper or coping-plate. The cop may be made larger or smaller. A larger wheel will make a larger cop, on account of the worm-shaft connected with the shaper or coping-plate moving slower; and a smaller wheel will make a smaller cop by the worm-shaft connected with the shaper or coping-plate moving quicker, there being a finger attached to the carriage which works the catch on the wheel of the worm-shaft, and causes the wheel to move one tooth each stretch, which gives the bevil to the coping-rail.

It is of the utmost importance that every attention be given to machinery by having every part of the machine properly adjusted, and set square with the scrolls and other bands of a proper tightness; and that regular cleaning and oiling be particularly attended to, which is indispensable in all machinery—the neglect of which causes machinery to work ill, and destroys it much sooner than it otherwise would have been had proper care been taken.

Neglect always brings the best machinery into disrepute, consequently is injurious to the best machinists, and trade generally suffers materially.

Within these last few years, there have been a number of patents obtained by different machinists for improvements in machinery, used in all the different operations of carding, drawing, slabbing, roving, spinning, and weaving.

HANK, OR PROPORTION OF HANK, ETC. IN EACH OPERATION.

The following examples will show the hank and the decimal, or proportion of hank, in each and every operation, from the spinning to the lap machine.

Suppose the numbers or counts of yarn be 40's, with a draught of 9.6, or $9\frac{6}{10}$, what hank roving will be required?

Draught, 9.6)40.0(4.1666, or $4\frac{1}{6}$ hank roving required.

```
                 384
                 ---
                  160
                   96
                  ---
                   640
                   576
                   ---
                    640       640
                    576       576
                    ---       ---
                     640       64
```

If the draught at roving-frame be 7.5, or $7\frac{1}{2}$, producing a $4\frac{1}{6}$ hank roving, what hank will the slabbing be, allowing 2 slabbings to each roving?

N. B.—Where there is doubling, multiply the hank, or proportion of hank, by the number of ends doubled, and divide by the draught.

Hank roving, $4\frac{1}{6}$, or 4.1666
2, number of ends doubled.

Draught $7\frac{1}{2}$, or 7.5)8.3333(1.1111, or $1\frac{1}{9}$ hank slabbing.
75
83
75
83
75
83
75
83
75
8

If the draught at the slabbing-frame be 6.875, and the slabbing be 1.1111, or $1\frac{1}{9}$ hank, what decimal or proportion of hank will the drawing be, put up at the back of slabbing-frame, there being no doubling?

Draught, 6.875)1.1111(0.1616 decimal, or proportion of hank, last head of drawing.
6875
42361
41250
11111
6875
42361
41250
1111

If 8 ends be put up at the last head of drawings, and the draught be 6.125, and the decimal of the hank 0.1616; what decimal, or proportion of hank will the drawings be that are put up?

0.1616 decimal, or proportion of hank at [last head.
8 ends doubling.

Draught, $6\frac{1}{8}$, or 6.125)1.2929(0.211 decimal, or proportion of hank at middle, or second head of drawings.
12250
6792
6125
6679
6125
554

If the hank drawing at second head be 0.211; what will the decimal, or proportion of hank be at the first head, if the draught be 6.25, and the doubling 8?

0.211 decimal, or proportion of hank at [middle head.
8 ends doubling.

Draught, $6\frac{1}{4}$, or 6.25)1.688(0.27 decimal, or proportion of hank at first head of drawings.
1250
4380
4375
5

If the decimal, or proportion of hank at the first head of drawings be 0.27, the draught 6.25, and the doubling 8; what decimal, or proportion of hank, will the carding be?

0.27 decimal of hank at first head of drawings.
8 ends doubling.

Draught, 6¼, or 6.25)2.1600(0.3456 decimal of hank carding.
1875
2850
2500
3500
3125
3750
3750

If the decimal of the hank-carding be 0.3456, and the draught at the carding-engine be 130; what will the decimal of the hank lap be?

Dr't at carding-engine, 130)0.3456(.00265846 decimal, or proportion of hank lap.
260
856
780
760
650
1100
1040
600
520
800
780
20

N. B.—The weight of any number of yards of carding or drawing may be found in the tables, according to the decimal, or proportion of hank.

If the decimal, or proportion of the hank lap be 0.00265846, and the draught at the lap machine be 2.75, or $2\frac{3}{4}$; what will the decimal, or proportion of the hank of cotton fed on feed-cloth at the lap machine be?

Draught at lap machine, 2.75)0.00265846(0.0009667 decimal of hank fed on feed-cloth at lap machine.
2475
1834
1650
1846
1650
1960
1925
35

If the decimal, or proportion of hank at the lap machine be 0.0009667; what will the net weight of cotton fed on 30 inches of feed-cloth at the lap machine be?

Look in the table of dividends for inches, and opposite 30 will be found 6.9444 the dividend; which, divided by 0.0009667 the decimal, or proportion of hank at the lap machine, will give the net weight of cotton in grains.

Decimal of hank, 0.0009667)6.9444(7183 grs., or 1 ℔., 0 oz., 7 dwts., 15 grains.
67669
17754
9667
80874
77336
35384
29001
6383

N. B.—The above weight being subtracted from the gross weight of cotton fed on feed-cloth at lap machine, will give the weight of loss sustained in working.

LOSS IN WORKING.

Suppose there be 18½ ounces of cotton fed on the feed-cloth at the lap machine, and the weight of yarn produced (as appears from the preceding example) be 1 ℔., 0 oz., 7 dwts., and 15 grains; what will the loss sustained in working be?

	oz.	dwts.	grs.	
18½ ounces, =	18 ..	9 ..	2¾	weight of cotton at lap machine.
	16 ..	7 ..	15	weight of yarn produced.
	2 ..	1 ..	11¾	weight lost in working.

Or,

The loss sustained in working any kind of cotton may be found in the following manner:—

Multiply all the draughts together successively for a divisor, and all the doublings together accordingly, and that product by the numbers of yarn produced for a dividend, and the quotient will be the decimal, or proportion of the hank.

Then look for the dividend in the table opposite the number of inches any given weight of cotton is fed on the feed-cloth at the lap machine, and divide by the decimal, or proportion of the hank, and the quotient will be the net weight in grains; which, subtracted from the weight of cotton fed on the feed-cloth at the lap machine, will show the loss sustained in working.

The loss sustained in each operation may be ascertained in the same manner.

Suppose the draughts and doubling are as follows: the numbers to be spun 40's, and the weight of cotton fed on 30 inches of feed-cloth at the lap machine be 18½ ounces; what will be the loss in working?

Draught at lap machine, 2.75.
Draught at carding-engine, 130.
Draught at 1st head-drawing, 6.25.
Draught at 2d head-drawing, 6.25.
Draught at 3d head-drawing, 6.125.
Draught at slabbing-frame, 6.875.
Draught at roving-frame, 7.5.
Draught at mules, 9.6.

Doubling 1st head-drawing, 8.
Doubling 2d head-drawing, 8.
Doubling 3d head-drawing, 8.
Doubling roving-frame, 2.

DRAUGHTS.

2.75 lap machine.
130 carding-engine.

8250
275

357.50
6¼ draught at 1st head-drawing.

2145.0
89375

2234.375
6¼ draught at 2d head-drawing.

13406.250
55859375

13964.84375
6⅛ draught at 3d head-drawing.

83789.06250
174560546875
[to the last head of drawings.
85534.66796875 total draught from lap machine
6.875 draught at slabbing-frame.

42767333984375
59874267578125
68427734375000
51320800781250

588050.84228515625

Draughts continued, } 588050.84228515625
7.5 draught at roving-frame.

2940254211142578125
4116355895996093755

4410381.317138671875
9.6 draught at mules.

26462287902832031250
396934318542480468755

Divisor 42339660.6445312500000 total draughts.

8 doubling 1st head-drawing.
8 doubling 2d head-drawing.

64
8 doubling 3d head-drawing.

512
2 doubling roving-frame.

1024 total doublings.
40's number spun.

Dividend 40960

42339660.64453125)40960.000000000000(0.0009674 decimal, or proportion of hank at lap machine.
38105694580078125

2854305419921875
2540379638671875

3139257812500000
2963776245117187

1754815673828125
1693586425781250

61229248046875

The dividend for 30 inches is 6.9444, which, divided by 0.0009674, the decimal or proportion of the hank at the lap machine, will give the weight of yarn in grains produced, which, subtracted from the 18½ ounces of cotton fed on the feed-cloth at the lap machine, will show the loss sustained in working.

Dec. or prop. of hank, 0.0009674)6.9444(7178 grains or 16 oz., 7 dwts., 10 grs. of yarn produced from 18½ oz. of cotton.
67718
17264
9674
75904
67718
81864
77392
4472

	oz.	dwts.	grains.
Cotton consumed at lap machine,	18	9	2¾
Yarns produced,	16	7	10
Loss sustained in working,	2	1	16¾

The weight of cotton fed on any given length of feed-cloth at the lap machine, reduced to grains, may be divided by the draughts, and multiplied by the doublings successively, through each operation, which will show the gross weight in grains for the same length, as the given length of feed-cloth at the lap machine, which may be extended to any length, the weight being in proportion.

The net weight of the same length, according to the hank or proportion of hank in the same operation, being subtracted from the gross weight, will show the loss sustained at each operation, or the whole loss throughout the different processes of working.

N. B.—Proceed with the same particulars as in the last examples.

If there be 18½ ounces of cotton fed on 30 inches of feed-cloth at the lap machine, what weight should the same length weigh at the different processes (allowing no loss), if the draughts and doubling be as follows?

DRAUGHTS.

Lap machine, 2.75, or $2\frac{3}{4}$.
Carding-engine, 130.
1st head of drawings, 6.25, or $6\frac{1}{4}$.
2d head of drawings, 6.25, or $6\frac{1}{4}$.
3d head of drawings, 6.125, or $6\frac{1}{8}$.
Slabbing-frame, 6.875, or $6\frac{7}{8}$.
Roving-frame, 7.5, or $7\frac{1}{2}$.
Mules, 9.6, or $9\frac{6}{10}$.

DOUBLING.

1st head of drawings, 8.
2d head of drawings, 8.
3d head of drawings, 8.
Roving-frame, 2.

Reduce $18\frac{1}{2}$ ounces to grains for the dividend.

437.5 grains=1 oz.
18.5, or $18\frac{1}{2}$ ounces of cotton fed on feed-cloth.
———
21875
35000
4375
———
Draught at lap ma. 2.75)8093.75(2943.2 grs., or 6 oz., 13 dwts. $6\frac{1}{5}$ grs., weight of 30 in. of lap.
550
———
2593
2475
———
1187
1100
———
875
825
———
500
550—nearly.

2943.2 grains, weight of 30 inches of lap; draught at the carding-engine 130.

130)2943.2(22.64 grains, weight of 30 inches of carding.
260
343
260
832
780
520
520

22.64 grains, weight of 30 inches of carding; draught at the 1st head of drawings 6.25, and doubling 8.

22.64 grains, weight of carding.
8 ends, doubling at 1st head of drawings.
Draught, 6.25)181.12(28.9792 grains, or 1 dwt., 4.9792 grs., weight of 30 inches of drawing at the 1st head.
1250
5612
5000
6120
5625
4950
4375
5750
5625
1250
1250

28.9792 grs., weight of drawing 1st head.
8 ends doubling.

Draught at 2d head of drawings, 6.25)231.8336(37.093 grains, or 1 dwt., 13.093 grs., weight of 30 inches of drawing 2d head.
1875
4433
4375
5836
5625
2110
1875
235

37.093 grains, weight of 30 inches of drawing at 2d head; draught at 3d head of drawings 6.125, and doubling 8.

37.093 grs., weight of 30 inches of drawing.
8 ends doubling.

Draught at 3d head of drawing, 6.125)296.746(48.448 grs., or 2 dwts., 0.448 grs., weight of 30 inches of drawing at the third head.
24500
51746
49000
27460
24500
29600
24500
51000
49000
2000

48.448 grains, weight of 30 inches of drawing at 3d or last head; draught at slabbing-frame 6.875 (no doubling).

Draught at slabbing-frame, 6.875)48.448(7.04698 grains, weight of 30 inches of slabbing.
48125
32300
27500
48000
41250
67500
61875
56250
55000
1250

7.04698 grs., weight of 30 in. of slabbing.
2 ends doubling at roving-frame.

Draught at rov.-frame, } 7.5)14.09396(1.88 grains, weight of 30 inches of roving.
75
659
600
593
600—nearly.

1.88 grains, weight of 30 inches of roving; draught at mules 9.6 (no doubling).

Draught at mules, 9.6)1.88(0.195833 decimal of a grain, weight of 30 inches of yarn.
96
920
864
560
480
800
768
320
320
288
320
288
32

0.195833 gr., weight of 30 inches of yarn.
144, the number of 30 inches in 1 lea, or 120 yards.
783333
783333
195833
28.200000 grains, weight of 1 lea.
25 grains, weight of 1 lea of 40's yarn.
3.2, or 3$\frac{1}{5}$ grains, loss in working 1 lea.
7 leas, 1 hank.
22.4 grains, loss in working 1 hank.
40 hanks, 1℔.
grains.
1 oz. is equal to 437.5)896.0(2 oz., 0 dwts., 21 grains, loss sustained in working 1℔.
8750
21.0

When 30 inches of feed-cloth is the length, any given weight of cotton is fed on at the lap machine. The table on the next page will show the multipliers for any number of yards weighed at any operation.

The number of grains in any operation, multiplied by the figures opposite the number of yards weighed, will give the gross weight, from which subtract the net weight. The difference will be the loss sustained in working the length weighed.

TABLE OF MULTIPLIERS.

For ascertaining the loss sustained in working any given length or weight of cotton yarn, as 1 lea, 1 hank, or 1℔., as shown in a preceding example.

Length weighed. Yards.	Multipliers.
1	1.2
2	2.4
3	3.6
4	4.8
5	6
6	7.2
7	8.4
8	9.6
9	10.8
10	12
20	24
30	36
40	48
50	60
60	72
70	84
80	96
90	108
100	120
110	132
1 lea, or 120	144
Leas.	
2	288
3	432
4	576
5	720
6	864
1 hank, or 7	1008

N. B.—Where 30 *inches is the length any given weight of cotton is fed on the feed-cloth at lap machine (which is nearly general), the above multipliers answer without exception.*

The proportion of the hank, and the weight of any given length, will be sufficiently explained in the foregoing rules, examples, and illustrations. However, it will not be out of place to give one or two more, as nothing in calculations is more essential to masters or managers.

According to a former example, 30 inches of roving weighs 1.88 grains (but no person can weigh to so great a nicety). I wish to know what 30 yards of the same roving will weigh, and what hank it is.

1.88 grains, weight of 30 inches of roving.
36 multiplier for 30 yards (see Table).

1128
564

67.68 grains, or 2 dwts., 19.68 grs., weight of 30 yards of roving.

250 is the dividend for 30 yards, which, divided by the number of grains it weighs, will give the hank roving.

grains. Dividend.
Weight of 30 yards, 67.68)250.00(3.693, or $3\frac{7}{10}$ hank rov. nearly.
20304

46960
40608

63520
60912

26080
20304

5776

If the hank roving when weighed be $4\frac{1}{6}$ or 4.166 hanks, what will be the loss sustained in working 30 yards?

250 is the dividend for 30 yards, which, divided by 4.166, the hank roving, will give the number of grains net weight.

Hank roving, =4.166)250.000(60 grains, net weight of 30 yards, of $4\frac{1}{6}$ hank roving.
25000

N. B.—For loss sustained in working, see next example.

If the weight of cotton required for 30 yards of roving be 67.68 grains, and the weight of the same length of roving be 60 grains, which is equal to 4.166 or 4$\frac{1}{6}$ hanks, what will the loss sustained in working be for 1 lea, 1 hank, and 1℔.?

67.68 grs., weight of cot. req'd for 30 yds. of rov.
60 grains, weight of 30 yards of roving.

7.68 grains, loss at 30 yards.
4 times 30 is equal to 120 yards, or 1 lea.

30.72 grains, loss at 1 lea.
7 leas, 1 hank.

215.04 grains, loss at 1 hank.
4.166 hank roving produced.

129026
129026
21504
86016

895.85686 grains, loss sustained in working 1℔. of cotton.

Or,

1 oz. is equal to 437.5 grs.)895.85686(2.0477 ounces.
8750 437$\frac{1}{2}$ grains are 1 oz.

20856 3339
17500 1431
1908
33568 238
30625
20.8687 grains, or 2 oz.
29436 0 dwts., 21 grs.
30625—nearly. nearly.

AVERAGE COP AND WEIGHT OF SETS.

To find the numbers of yarn and the number of hanks in one set of cops (from an average cop), the weight of the set being given.

RULE.—Multiply the length on one cop by the number of spindles in the wheels for the number of hanks in the set; then divide by the weight of the set, and the quotient will be the numbers of yarn.

If a set of cops from a pair of wheels containing 808 spindles weighs 30 lbs., and the length on one cop be 1 hank, 6 leas, and 70 threads, what number of hanks will there be in the set, and what number of yarn will it be?

	Hank.	Leas.	Threads.	
One cop contains	1	6	70	
			10 × 10 × 8 add 8=808 spdls.	
	19	5	60	
			10	
	198	1	40	
			8	
	1585	5	0	
	15	6	0=8	
Wght.of sets 3.0 lbs.,	160.1	4	0	No. of hanks on 1 set.
	53.4 nearly, hanks fineness of Nos. of yarn.			

Or,

Reduce the length on one cop to threads, and multiply by the number of spindles in the wheels; then divide by the number of threads in one lea, the quotient of which must be divided by the number of leas in one hank, and that quotient will be the number of hanks contained in the set; then the number of hanks contained in the set must be divided by the weight of set, and the quotient will be the number of hanks in 1lb.

Hank. Leas. Threads.
One cop contains 1 . . 6 . . 70
7 leas, 1 hank.

13
80 threads, 1 lea.

1110 threads on one cop.
808 spindles in the pairs of wheels.

8880
88800

1 lea, 8.0 thrds.)89688.0 threads on 1 pair of sets.

1 hank, 7 leas,)11211 leas on one pair of sets.

1601.5714 hanks on 1 pair of sets.
7 leas, 1 hank.

3.9998 leas.
80 threads, 1 lea.

79.9840 threads.

The length of yarn on one pair of sets will be 1601 hanks, 4 leas.

Weight of set, 3.0 ℔s.)160.1.5714 hanks on one pair of sets.

53.3857, or rather more than 53$\frac{1}{3}$ Nos. of yarn.

What will one set of cops weigh, if the wheels contain 808 spindles, the numbers of yarn 53 hanks to the pound, the number of stretches 1000, and the length of the stretch put up 60 inches?

Multiply the number of stretches, the length of stretch, and the number of spindles in the wheels together respectively for a dividend; then multiply the numbers of yarn by 840 and 36 respectively for a divisor, and the quotient will be the weight of the set.

1000, number of stretches on one cop.
60 inches, length of stretch.

60000
808 number of spindles in wheels.

48480000 dividend.

840 yards, 1 hank.
36 inches, 1 yard.

5040
2520

30240 inches in 1 hank.
53, numbers of yarn.

90720
151200

1602720 divisor.

1602720)48480000(30lbs., 3¾ oz., weight of set.
4808160

398400
16 ounces, 1lb.

2390400
398400

1602720)6374400(3 ounces.
4808160

1566240
4 qrs., 1 ounce.

1602720)6264960(3 qrs.
4808160

1456800

What will the weight of one pin or shuttle-cop of 36's weft be, containing 450 stretches, each stretch 57 inches net (allowed for breakage).

450, number of stretches on cop.
57 inches, length of stretch.
3150
2250
1 yard is 36 inches,)25650(712.5 yards.
252
45
36
90
72
180
180

1 lea is 120 yards,)712.5(5.9375 leas on 1 cop.
600
1125
1080
450
360
900
840
600
600

Leas.
Nos. of weft, 36's)5.937.5(164.93 grains, or 6 dwts., 20.93 grs., weight on 1 cop.
36
233
216
177
144
335
324
110
108
2

How many leas and threads are there in one cop, containing 712½ yards?

1 lea is 120 yards,)712.5(5 leas, 75 threads, on 1 cop.
600

1½ yards is 1 thread, 1.5)112.5(75 threads.
105
75
75

N. B.—In ascertaining the weight of one cop, reckon your dividend as many thousands as you have leas; and where the decimal of a lea occurs, which is generally the case, put the point in, reserving the thousands, which, divided by the numbers of yarn, will give the weight of the cop in grains.

What will one cop of 36's twist weigh, containing 900 stretches, each stretch 61½ inches, exclusive of breakage?

900, number of stretches.

61.5 or $61\frac{1}{2}$ inches, length of stretch.

1 yard is 36 inches, { 6)55350.0

6)9225

1 lea is 12.0 yards,)153.7.5 yards on 1 cop.

12.8125 leas on 1 cop.

Nos. of yarn, 36)12812.5(355.9 grains, or 14 dwts., 19.9 grains, weight of 1 cop.

108

201

180

212

180

325

324

1

What will one cop of 48's twist weigh; if it contains 1200 stretches, each stretch to put up 61 inches, exclusive of breakage?

1200, number of stretches.

61 inches, length of stretch.

1200

7200

1 yard is 36 inches, { 6)73200 inches on 1 cop.

6)12200

1 lea is 12.0 yards,)203.3.3 yards on 1 cop.

16.944 leas, or 2 hanks, 2.944 leas on 1 cop.

Leas.

$$\text{Nos. of yarn, } 48\begin{cases} 4)16.944 \\ \hline 12)4236 \end{cases}$$

353, grains, or 14 dwts., 17 grains, weight of 1 cop.

WEIGHT OF SETS.

The number of hanks, and weight of a pair of sets of cops, are required from the following particulars:—

Number of spindles, 1008.
Number of stretches, 900.
Length of stretches, 61½ inches.
Numbers of yarn, 36 hanks to 1 lb.

1008 number of spindles in mules.
900, number of stretches.

907200
61.5, or 61½ inches, length of stretch.

4536000
907200
5443200

55792800.0 inches of yarn on 1 pair of sets.

1 yard is 36 inches,)55792800(1549800 yards on 1 set of cops.
36

197
180

179
144

352
324

288
288

1 lea is 12.0 yds.)154980.0 yards on 1 set of cops.

1 hank is 7 leas,)1291·5 leas on 1 set of cops.

Nos. of yarn, 36, 6)1845 hanks on 1 set of cops.
6)307.5

51.25 lbs., or 51 lbs., 4 oz., weight of set.
16 ounces 1 lb.

150
25

4.00 ounces.

The number of hanks in a pair of sets of cops is required from the following particulars:—

Number of spindles in mules, 1340.
Number of stretches, 1200.
Length of stretches, 59.5 inches.

1340 spindles in mules.
1200 stretches.

1608000
59.5, or 59½ inches, length of stretch.

8040
14472
8040

1 yd. is 36 in. 6)95676000.0 yards of yarn on 1 set of cops.
6)15946000

1 lea is 12.0 yds.)265766.6.6 yards of yarn on 1 set of cops.

1 hank is 7 leas,)22147.222 leas of yarn on 1 set of cops.

3163.888 hanks of yarn on 1 set of cops.

3163.888 hanks of yarn on 1 set of cops.
7 leas, 1 hank.

6.222 leas.
120 yards, 1 lea.

26.666 yards.

SPINNER'S BOOK, &c.

Where it is customary to pay the spinners at the rate of so much per thousand hanks, the length of the average cop from each set may be put down for the week; then add them together and multiply by the number of spindles in the mules, as follows:

Number of spindles in mules.	Weight of sets.		Average cop.		
	lbs.	oz.	hanks.	leas.	threads.
1008	51	8	1	5	65
“	50	4	1	4	72
“	52	6	1	6	36
“	51	12	1	5	60
“	51	10	1	5	14
“	52	8	1	6	10
“	52	4	1	5	32
“	51	12	1	5	64
“	52	4	1	6	38
“	52	8	1	6	14
“	51	0	1	5	0
“	50	4	1	4	18
Total for 1 week.	620	0	21	4	23

Hanks. Leas. Threads.
21 .. 4 .. 23
7 leas, 1 hank.

151
80 threads, 1 lea.

12103
1008 spindles in mules.

96824

96824
1210300

Threads in 1 lea, 8.0)1219982.4 threads.

1 hank is 7 leas,)152497..64, or 152497 leas, 64 threads.

21785..2..64, or 21785 hanks, 2 leas, 64 threads, number of hanks on 1 pair of sets of cops.

Total weight, 620 lbs.)21785(35$\frac{1}{8}$ hanks, average number of yarns.
1860

3185
3100

85

The number of hanks per spindle will be ascertained by dividing the number of hanks spun, by the number of spindles in the mules, or throstles.

If the total number of hanks spun in a week be 21745, and the number of spindles in the mules be 1008; what number of hanks per spindle will be produced?

1008)21745(21.5724, or 21 hanks, 4 leas per spindle.
2016 7 leas, 1 hank.

1585 4.0068 leas.
1008 120 yards, 1 lea.

5770 .8160
5040

7300
7056

2440
2016

4240
4032

208

The spinner's book should be made up so that the weight, numbers of yarn, the total number of hanks, and the number of hanks per spindle per week, would appear at one view, for the satisfaction of the employers, and the government of the managers.

THE FOLLOWING FORM MIGHT BE ADOPTED.

Date. 1839.	Name.	Weight. lbs.	Number.	Total number of hanks.	No. of hanks per spindle.	Rate.	£	s.	d.
April 17	John Pollard.	620	35⅛	21745	21.5724	⅔	2	8	11

N. B.—The form of the book may be altered according to the system of spinning and paying, but the above particulars should always appear.

DRESSING MACHINE.

Dressing machines are of various constructions, and, like most other machines, have been greatly improved; however, the necessary calculations will be easily ascertained from the following examples.

The speed of the crank-shaft, on which is fixed the top, or large cone drum, is required from the following particulars:—

Revolutions of driving-shaft a minute, 66.
Diameter of drum on shaft, 18 inches.
Diameter of pulley on crank-shaft, 17½ inches.

66 revolutions of driving-shaft a min.
18, diameter of drum on driving-shaft.

528
66

1188

In. diam. of pul. on crank-shaft, } 17.5)1188(67.885714 revolutions of crank shaft a minute, on which is fixed the top, or large cone drum.
1050
———
1380
1225
———
1550
1400
———
1500
1400
———
1000
875
———
1250
1225
———
250
175
———
750
700
———
50

The speed of the fan at dressing machine is required from the following particulars:—

Revolutions of crank-shaft a minute, 67.885714.
Diameter of pulley on crank-shaft for driving fan, 25 inches.
Diameter of pulley on the end of fan, 2 inches.

67.885714 revols. of crank-shaft per min.
25 in., diam. of pul. on crank-shaft.
———
339428570
135771428
———
In. diam. of pul. on the end of fan, } 2)1697.142850
———
848.571425 revolutions of fan a minute.

The speed of the fan at dressing machine is required from the following particulars:—

Revolutions of driving-shaft a minute, 66.
Diameter of drum on shaft, 18 inches.
Diameter of drum on crank-shaft, 17½ inches.
Diameter of pulley on crank-shaft for driving fan, 25 inches.
Diameter of pulley on end of fan, 2 inches.

66 revolutions of driving-shaft a min.
18 inches, diam. of drum on driving-shaft.

528
66

1188
25 inches, diam. of pulley on crank-shaft for driving fan.

5940
2376

29700 dividend.

17.5 inches, diameter of pulley on crank-shaft.
2 inches, diameter of pulley on end of fan.

35.0 divisor.

$$35\left\{\begin{array}{r}5)29700\\ \hline 7)5940\end{array}\right.$$

848.571428 revolutions of fan per minute.

If the fan of a dressing machine makes 848.571428 revolutions a minute, and its diameter is 18 inches; how many yards will it traverse a minute?

848.571428 revolutions of fan a minute.
1.5 foot, = 18 in. diam. of fan.

4242857140
848571428

1272.8571420

1272.8571420
3.1416 circum. when the diam is 1.

7637142852
1272857142
5091428568
1272857142
3818571426

1 yard = 3 feet)3998.8079973072 feet, fan traverses a minute.

1332.93566576906 yards, fan traverses a min.

The fan of a dressing machine (as in the above example) will traverse a space equal to 1333 yards nearly.

The speed of the under cone drum is required from the following particulars:—
Revolutions of crank, or top cone drum-shaft, 67.885714 a min.
Diameter of top cone drum, 11¾ inches.
Diameter of bottom cone drum, 4¾ inches.

67.885714 revols. of top cone drum-shaft a min.
11.75, or 11¾ inches, diam. of top cone drum.

339428570
475199998
746742854

797.65713950 dividend.

Diam. of under cone drum, 4.75 in.)797.6571395(167.9278 revols. of under cone drum a min.
475

3226
2850

3765
3325

4407
4275

1321
950

3713
3325

3889
3800

89

N. B.—The preceding example shows the greatest speed that the under cone drum can work; the largest diameter of the top cone, and the smallest diameter of the under cone being given, i. e., *the greatest speed that can be given to the motions connected with the top beam on which the dress yarn is.*

The speed of the top beam can be regulated by a worm, or screw-shaft, which works the strap on the drums, and must be done according to the heat, or drying, and fineness of yarns.

The speed of the top, or dressed yarn beam, is required from the following particulars.

Revolutions of under cone-shaft a minute, 167.9278.
Wheel on the end of cone-shaft, 74 teeth.
Wheel on foot of upright-shaft, 44 teeth.
Single worm on top of upright-shaft.
Wheel on shaft for working top beam, 68 teeth.

167.9278 revols. of under cone drum a min.
74 teeth wheel on the end of do.

6717112
11754946

12426.6572 dividend.

44 teeth, wheel on foot of upright-shaft.
68 teeth, wheel on shaft for working top beam.

352
264

2992 divisor.

2922)12426.6572(4.1533 revols. a min. of top, or dressed yarn beam, at the bottom or beginning.
11968

4586
2992

15945
14960

9857
8976

8812
8976—nearly.

N. B.—The top, or dressed yarn beam, decreases in speed as it fills, continuing to traverse over the same surface as at the commencement, so that the yarn is dried regularly.

If the heat, or drying increases, or decreases, which is sometimes the case, then the top, or dressed yard beam, must be regulated in speed accordingly, which will be done by moving the strap on the cone drums by the worm, or screw attached for that purpose.

PARTICULARS OF DRESSING FRAME.

Revolutions a min. of crank, or top cone drum-shaft, 67.885714.
Revolutions of fan a minute, 848.571425.
Revolutions of under cone a minute, at the bottom of beam, 167.9287.
Revolutions of top, or dressed yarn beam a minute, at the bottom of beam, 4.1533.
Diameter of pulley on crank, or top cone drum-shaft, 17½ inches.
Diameter of pulley on crank, or top cone drum-shaft for driving fan, 25 inches.
Diameter of pulley on end of fan, 2 inches.
Diameter of fan, 18 inches.
Diameters of top cone drum, 11¾ and 6 inches.
Diameters of under cone drum, 10½ and 4¾ inches.
Radius of crank for brushes, 3 inches.
Radius of crank for leverage, 1¾ inch.
Traversing of fan a minute, 1333 yards, nearly.

N. B.—The dimensions of the cone drums are the two extremes.

What number of ends must there be on each twist beam, allowing 8 beams to a machine, *i. e.* 4 beams to each side, to produce a piece of cloth 29½ inches wide, in a 72 reed, Manchester and Stockport count?

29.5, width of warp at the end.
72 reed, Manchester & Stockport count.
———
590
2065
———
Number of beams, 8)2124.0 total number of ends in the warp.
———
265.5 number of ends on each beam.

N. B.—The number of ends required for each beam is 265.5, *which may be made into* 266, *and make two twisters, or double ends at the selvage, at each side of the machine.*

What number of ends will it require to produce a top, or dressed yarn beam, to fill $51\frac{1}{2}$ inches in an 84 reed, Manchester and Stockport count; and what number of ends must there be on each twist beam, allowing 8 twist beams to a machine?

51.5 in., width of top, or dres'd yarn bm. at reed.
84 reed, Manchester and Stockport count.

2060
4120

Num. of bms. 8)4326.0 number of ends in dressed yarn beam.

540.75 number of ends required on each twist bm.

N. B.—Add as many ends as are required, according to the number of double ends wanted at the selvages.

If there be 542 ends on a twist beam, and 8 beams to a machine; how many ends will there be in the dressed yarn or top beam?

542 ends on each twist beam.
8 beams to a machine.

4336 ends on dressed yarn, or top beam.

N. B.—The bell wheel at the dressing machine must be regulated according to the size of your under roller, and length of piece required.

POWER-LOOM.

The number of picks a minute is required from the following particulars:—

Revolutions of driving-shaft a minute, 102.
Diameter of drum on driving-shaft, 14 inches.
Diameter of pulley on loom, 11 inches.

102 revols. of driving-shaft a min.
14 in. diam. of drum on same shaft.
408
102
In. diam. of pul. on loom, 11)1428
129.818 number of picks a min.

If the crank-shaft of a loom makes 129.818 revolutions a minute, with a wheel 50 teeth fixed on the end, working into a wheel with 100 teeth on the end of the tappet-shaft; what number of revolutions will the tappet-shaft make a minute?

129.818 revolutions of crank-shaft a min.
50 teeth on end of crank-shaft.
Teeth on end of tappet-shaft, } 100)6490.900
64.909 revolutions a min. of tapt.-shaft.

N. B.—The above examples only refer to plain cloths, but the calculations of twills, fustians, and all other fancy goods, are regulated by the number or different constructions of the tappets working upon the treadles, or levers, connected with the healds, whereby nearly any pattern may be constructed and manufactured as by hand-weaving.

The number of picks a minute is required from the following particulars:—

Revolutions of driving-shaft a minute, 98.25
Diameter of drum on driving-shaft, 15.5 inches.
Diameter of pulley on crank-shaft, 12.75 inches.

98.25 revolutions of driving-shaft a minute.
15.5, or 15½ in. diam. of drum on driving-shaft.
49125
49125
9825
1522.875 dividend.

Inches diam. of pulley on crank-shaft, 12¾, } 12.75)1522.875(119.441 revolutions of crank-shaft a minute.
1275
2478
1275
12037
11475
5625
5100
5250
5100
1500
1275
225

The speed of the tappet-shaft is required from the following particulars:—

Revolutions of crank-shaft a minute, 119.441.
Wheel on end of crank-shaft, 50 teeth.
Wheel on end of tappet-shaft, 100 teeth.

119.441 revols. of crank-shaft a min.
50 teeth, wheel on crank-shaft.

Whl. on tapt.-shft. 100 tth.)5972.050

59.7205 revolutions of tappet-shaft a minute.

If the crank-shaft of a power-loom makes 129.818 revolutions, *i. e.* picks, a minute; what time will be required to work successively, to produce a piece of cloth 29 yards long, with 88 picks, or threads in 1 inch?

29 yards, length of piece.
37 inches, length hooked for 1 yard.

203
87

1073 number of inches in 1 pick.
88 number of picks in 1 inch.

8584
8584

Dividend 94424 total number of picks in 1 piece, 29 yards long.

Num. of picks a min., 129.818)94424.00(727.3567 mins. required to work successively, to produce 1 piece of cloth, 29 yards long, or 12 hours, 7 mins., 21.402 seconds.
908726

355140
259636

955040
908726

463140
389454

736860
649090

877700
778908

987920
908726

79194

The length of time required for the loom to work successively, to produce 1 piece of cloth 29 yards long with 88 picks, or threads in 1 inch, will be 12 hours, 7 minutes, and 21 seconds.

N. B.—The distance of the hooks on all frames for hooking pieces is 37 *inches.*

If the crank-shaft of a power-loom makes 119.441 revolutions a minute, *i. e.* so many picks or threads; what length of time must it work successively, to produce a piece of cloth 29 yards long with 84 picks, or threads in 1 inch?

29 yards, length of piece.
37 inches, length hooked for 1 yard.
203
87
1073 number of inches in 1 piece of cloth.
84 number of picks or threads in 1 inch.
4292
8584
Dividend 90132 number of picks in 1 piece of cloth 29 yards long.

Num. of picks a min., 119.441)90132.0(754.615 minutes, or
836087 60)754.615
652330 12..34..615
597205 60s.1m.
551250 36.900
477764
734860
716646
182140
119441
626990
597205
29785

The length of time required for the loom to work successively, to produce a piece of cloth of the foregoing description, will be 12 hours, 34 minutes, 37 seconds, nearly.

The weight of yarn is required, to make one piece of cloth, of the following description:—

Length of piece, 29 yards.
Count of reed, 72. (Manchester and Stockport count.)
Numbers of twist, 36's.
Width of warp at the reed, 29½ inches.
Number of picks in 1 inch, 88.
Number of weft, 36's.

```
                        29 yards, length of piece.
                        72, Manchester and Stockport count of
                       ----                               reed.
                        58
                      203
                      ----
                      2088
                        29½ inches, width of warp at the reed.
                     -----
                     18792
                     4176
                      1044
                     -----
1 hank is 840 yards,)61596(73.328 hanks of twist required for
                     5880                              the piece.
                     -----
                      2796
                      2520
                      -----
                       2760
                       2520
                       -----        7200
                        2400        6720
                        1680        ----
                        -----        480

                        29 yards, length of piece.
                        88 picks or threads in 1 inch.
                       ----
                        232
                       232
                       ----
                       2552
                        29.5, or 29½ inches, width at the reed.
                      -----
                      12760
```

12760
22968
5104

75284.0

1 hank is 840 yards,)75284.0(89.624 hanks of weft required for the piece.
6720

8084
7560

5240
5040

2000
1680

3200
3360—nearly.

73.328 hanks of twist.
89.624 hanks of weft.

Numbers of yarn, 36 { 6)162.952 hanks of yarn required for 1 piece.
6)27.158

4.526 ℔s. of yarn.
16 oz., 1 ℔.

3156
526

8.416 ounces.
4 qrs. 1 ounce.

1.664 qrs.

The weight of yarn required for the piece is 4 ℔s. $8\frac{1}{2}$ oz., nearly.

Or,

When the numbers of twist and weft are the same, the question may be worked in one operation, by adding the Manchester or

Stockport count of reed, and the number of picks, or threads required in the inch together, and then proceed as in either of the last examples.

Thus,

72, Manchester or Stockport count of reed.
88 picks, or threads in 1 inch.

160
29 yards, length of piece.

1440
320

4640
29.5 inches width at the reed.

23200
41760
9280

136880.0 dividend.

Yards in 1 hank, 840
Numbers of yarn, 36

5040
2520

Yards in 1 ℔., 30240)136880.0(4.526 lbs. of yarn.
120960

159200
151200

80000
60480

195200
181440

13760

The weight of yarn required for the piece is 4 lbs., 8½ oz., nearly as in the last example.

THE DRIVING AND DRIVEN WHEELS REQUIRED TO PRODUCE ANY GIVEN DRAUGHT BETWEEN THE MIDDLE AND BACK ROLLERS, AND BETWEEN THE BACK AND FRONT ROLLERS, THE DIAMETER OF THE ROLLERS BEING GIVEN.

WHEELS REQUIRED TO PRODUCE ANY GIVEN DRAUGHT FOR BACK AND MIDDLE ROLLERS.

RULE.—Multiply the length you intend drawing, by the diameter of the middle roller, for the driving-wheel; and the length you wish that drawn into, by the diameter of the back roller, for the driven-wheel.

If a greater or less number of teeth be required in the wheel, divide the driver and driven-wheels by any number that will divide both without a remainder; then multiply the quotients by any number, according to the number of teeth wanted in the wheels.

N. B.—The diameter of the wheels will be according to the pitch of the teeth.

What number of teeth must there be in the wheel required, for the back and middle rollers to produce a draught of 1 into 2, allowing the back roller to be $\frac{7}{8}$ inch, and middle roller 1 inch in diameter?

1 into 2 draught
Middle roller 1 inch, or 8 7, or $\frac{7}{8}$ inch back roller.

Divided by 2)8 14

Quotients 4 and 7
Multipliers 5 5

Mid. rol., driving-wheel 20 tth. 35 teeth, driven-wheel.

Required the draught between the middle and back rollers, from the following particulars:—

Wheel on middle roller, (driving-wheel,) 20 teeth.
Wheel on back roller, (driven-wheel,) 35 teeth.
Diameter of middle roller, 1 inch.
Diameter of back roller, $\frac{7}{8}$ inch.

	Driving-wheel.	Driven-wheel.
	20 teeth.	35 teeth.
In. diam. of back roller., $\frac{7}{8}$	7	1 inch, or 8, diam. of middle rol.
	140	140)280(2, or 1 into 2 draught,
		280 between middle and back rollers.

What number of teeth must there be in the wheels on the back and middle rollers, to produce a draught equal to 2 into 3, if the back roller be $\frac{7}{8}$ inch, and the middle roller 1 inch in diameter?

	2	into 3 draught,
Middle roller, 1 inch, or	8	7, or $\frac{7}{8}$ inch back roller.
Middle roller wheel,	16	21 wheel on back roller.
	2	2
Middle roller wheel,	32 tth.	42 teeth, wheel on back roller.

The draught between the middle and back rollers is required from the following particulars:—

	Driving-wheel.	Driven-wheel.
	16 teeth.	21 teeth.
Diameter of back roller,	7	8, or 1 inch diam. of mid. rol.
	112	)168(1.5, or 2 into 3 draught.
		112
		560
		560

Or,

	Driving-wheel.	Driven-wheel.
	32 teeth.	42 teeth.
Diameter of back roller,	7	8, or 1 in. diam. of mid. rol.
	224	)336(1.5, or 2 into 3 draught.
		224
		1120
		1120

What number of teeth must there be in the wheels on the back and middle rollers, to produce a draught equal to 3 into 4, if the back and middle rollers be the same diameters?

3 into 4 draught.
7 7
— —
Middle roller wheel, 21 tth. 28 teeth, back roller wheel.

The draught between the middle and back roller is required from the following particulars, the diameters of the rollers being the same:—

Driving-wheel. Driven-wheel.
21 21)28($1\frac{1}{3}$, or 3 into 4 draught.
21
—
7

$$\frac{7}{21} = \frac{1}{3}$$

The wheels for the back and middle rollers are required to produce a draught of 3 into 4, the diameter of the back roller being 1 inch, and the middle roller $1\frac{1}{8}$ or $\frac{9}{8}$ inch diameter:—

3 into 4 draught.
Middle roller, $\frac{9}{8}$ inch 9 8, or 1 inch back roller.
— —
27 tth. 32 teeth, wheel for back roller.

The draught between the middle and back rollers is required from the following particulars:—
Wheel on middle roller, 27 teeth. Diam. of middle roller, $1\frac{1}{8}$ inch.
Wheel on back roller, 32 teeth. Diameter of back roller, 1 inch.

Driving-wheel. Driven-wheel.
27 teeth. 32 teeth.
Back roller 1 inch, or 8 9, or $1\frac{1}{8}$ inch, middle roller.
— —
216)288($1\frac{1}{3}$, or 3 into 4 draught.
216
—
72

$$\frac{72}{216} = \frac{1}{3}$$

What wheels will be required to produce a draught of 4 into 5, between the middle and back rollers, if the back roller be $\frac{7}{8}$ inch, and the middle roller 1 inch diameter?

4 into 5 draught.
Middle roller, 1 inch, or 8 7, or $\frac{7}{8}$ inch back roller.
— —
Middle roller wheel, 32 tth. 35 teeth, wheel back roller.

The draught between the back and middle rollers is required from the following particulars:—
Wheel on middle roller, 32 teeth. Diam. of middle roller, 1 inch.
Wheel on back roller, 35 teeth. Diameter of back roller, $\frac{7}{8}$ inch.

Driving-wheel. Driven-wheel.
32 teeth. 35 teeth.
Back roller, $\frac{7}{8}$ inch or 7 8, or 1 inch, middle roller.
——— ———
224)280(1.25, or 4 into 5 draught.
224
———
560
448
———
1120
1120

What wheels will be required to produce a draught of 5 into 6, between the middle and back rollers, if the back roller be $\frac{7}{8}$ inch and the middle roller 1 inch diameter?

5 into 6 draught.
Middle rollers, 1 inch or 8 7, or $\frac{7}{8}$ inch, back roller.
— —
Divide by 2)40 tth. 42 teeth, wheel back roller.
— or —
Middle roller wheel, 20 tth. 21 teeth, wheel back roller.

The draught between the middle and back rollers is required from the following particulars:—

Driving-wheel. Driven-wheel.
40 teeth. 42 teeth.
Back roller, $\frac{7}{8}$ inch, or 7 8, or 1 inch, middle roller.
280)336(1.2 or 5 into 6 draught.
280
560
560

N. B.—The wheels may be reduced to 20 *and* 21, *and the draught will be the same.*

What wheels will be required to produce a draught of 6 into 7, between the middle and back rollers, if the back roller be $\frac{7}{8}$ inch and the middle roller 1 inch diameter?

6 into 7 draught.
Middle roller 1 inch or 8 7, or $\frac{7}{8}$ inch back roller.
Middle roller wheel, 48 tth. 49 teeth, wheel on back roller.

If there be a wheel 48 teeth on the middle roller, working into a wheel 49 teeth on the back roller, and the back roller be $\frac{7}{8}$ inch, and the middle roller 1 inch diameter; what will the draught be?

Driving-wheel. Driven-wheel.
48 teeth. 49 teeth.
Back roller, $\frac{7}{8}$ inch, or 7 8, or 1 inch middle roller.
336)392(1$\frac{1}{6}$, or 6 into 7 draught.
336

$$\frac{56}{336}=\frac{1}{6}$$

What wheels will it require to produce a draught between the middle and back rollers of 7 into 8, if the back roller be $\frac{7}{8}$ inch, and the middle roller 1 inch diameter?

7 into 8 draught.

Middle roller, 1 inch, or 8 7, or $\frac{7}{8}$ inch back roller.

Divided by 8)56 56

Lowest number 7 7 lowest number.

3 3

Middle roller wheel 21 tth. 21 teeth, wheel back roller.

The draught between the middle and back rollers is required from the following particulars:—

Wheel on the middle roller 21 teeth, working into wheel on stud 40 teeth, which works wheel 21 teeth on back roller.

Diameter of the middle roller 1 inch, and diameter of the back roller $\frac{7}{8}$ inch.

Driving-wheel. Driven-wheel.

21 teeth. 21 teeth.

Back roller, $\frac{7}{8}$ inch 7 8, or 1 inch, middle roller.

147)168(1$\frac{1}{7}$, or 7 into 8 draught.

147

21

$$\frac{21}{147} = \frac{1}{7}$$

What wheels will be required for the middle and back rollers, to produce a draught of 7 into 8; allowing the back and middle rollers to be the same diameters?

7 into 8 draught.

2 2

Middle roller wheel, 14 tth. 16 teeth, wheel back roller.

Or,

7 into 8

3 3

Middle roller wheel, 21 tth. 24 teeth, wheel back roller.

Or,

7 into 8

4 4

Middle roller wheel, 28 tth. 32 teeth, wheel back roller.

The draught between the middle and back rollers is required from the particulars in the last example:—

Driving-wheel. Driven-wheel.
teeth.
14 teeth,)16($1\frac{1}{7}$, or 7 into 8 draught.
14
—
$\frac{2}{14}$ or $\frac{1}{7}$.

21 teeth,)24($1\frac{1}{7}$, or 7 into 8 draught.
21
—
$\frac{3}{21}$ or $\frac{1}{7}$.

28 teeth,)32($1\frac{1}{7}$, or 7 into 8 draught.
28
—
$\frac{4}{28}$ or $\frac{1}{7}$.

What wheels must there be on the middle and back rollers, to produce a draught of 8 into 9, if the back roller be $\frac{7}{8}$ inch, and the middle roller $\frac{3}{4}$ inch diameter?

8 into 9 draught.
Middle roller, $\frac{3}{4}$ inch, or 6 7, or $\frac{7}{8}$ inch, back roller.
— —
Middle roller wheel, 3)48 tth. 63 teeth, back roller wheel.
— —
Middle roller wheel, 16 tth. 21 teeth, back roller wheel.
2 2
— —
Middle roller wheel, 32 tth, 42 teeth, back roller wheel.

The draught between the middle and back rollers is required from the following particulars:—

Driving-wheel. Driven-wheel.
Wheel on middle roller, 32 teeth. 42 teeth, wheel on back roller.
7 6

224)252($1\frac{1}{8}$, or 8 into 9 draught.
224

$\frac{28}{224}$ or $\frac{1}{8}$.

What wheels will be required to produce a draught of 9 into 10, between the middle and back rollers, allowing the back and middle rollers to be the same diameter?

9 into 10 draught.
2 2

Wheel on middle roller, 18 tth. 20 teeth, wheel on back roller.

Or,

9 into 10
3 3

Wheel on middle roller, 27 tth. 30 teeth, wheel on back roller.

Or,

9 into 10
4 4

Wheel on middle roller, 36 tth. 40 teeth, wheel on back roller.

If there be a wheel 40 teeth on back roller, and a wheel 36 teeth on middle roller; what draught will there be if the middle and back rollers are the same diameter?

teeth.
Wheel on middle roller, 36 teeth.)40($1\frac{1}{9}$, or 9 into 10 draught.
36

$\frac{4}{36}$ or $\frac{1}{9}$.

If the back roller be 1 inch, and the middle roller $\frac{7}{8}$ inch diameter; what wheels will be required to produce a draught of 9 into 10, between the middle and back rollers?

9 into 10
Middle roller, $\frac{7}{8}$ inch, or 7 8, or 1 inch, back roller.
— —
Middle roller wheel, 63 tth. 80 teeth, wheel back roller.

The draught between the middle and back rollers is required from the following particulars:—

Wheel on middle roller, 63 teeth.	Wheel on back roller, 80 tth.
Diameter of middle roller, $\frac{7}{8}$ inch.	Diameter of back roller, 1 in.

Driving-wheel. Driven-wheel.
63 teeth. 80 teeth.
Back roller, 1 inch, or 8 7, or $\frac{7}{8}$ inch middle roller.
——— ———
504)560(1$\frac{1}{9}$, or 9 into ten draught.
504
———
56
$\frac{56}{504}=\frac{1}{9}$

If the back roller be $\frac{7}{8}$ inch, and the middle roller $\frac{3}{4}$ inch diameter; what wheels will be required to produce a draught of 10 into 11, between the middle and back rollers?

10 into 11
Middle roller, $\frac{3}{4}$ inch, or 6 7, or $\frac{7}{8}$ inch, back roller.
— —
Middle roller wheel, 60 tth. 77 teeth, wheel on back roller.

Or,

If the back and middle rollers were the same diameter.

10 inch 11
2 2
— —
Middle roller wheel, 20 tth. 22 teeth, wheel on back roller.

Or,

10 into 11
3 3
—— ——
Middle roller wheel, 30 tth. 33 teeth, wheel on back roller.

If the wheel on the back roller be 77, and the wheel on the middle roller 60, and the back roller $\frac{7}{8}$ inch, and the middle roller $\frac{3}{4}$ inch diameter, required the draught?

Driving-wheel. Driven-wheel.
60 teeth. 77 teeth.
Back roller, $\frac{7}{8}$ inch, 7 6, or $\frac{3}{4}$ inch, middle roller.
—— ——
420)462(1.1, or 10 into 11 draught.
420
——
420
420

TOTAL DRAUGHT IN ROLLERS.

RULE.—Multiply the diameter of the front roller by any number that will produce a wheel of a sufficient diameter for the first driving; then multiply the diameter of the back roller by twice the number the front roller is multiplied by for the first driven wheel, which will produce a draught equal to 2. If a draught of 3 be required, multiply the diameter of the back roller by 3 times the number by which the front roller is multiplied; if any intermediate draught between the whole numbers be required, as $2\frac{1}{8}$, $2\frac{1}{4}$, or $2\frac{1}{2}$, add to the product in proportion; and if above 3 of a draught be required, proceed accordingly.

The first driving and driven-wheels being ascertained, divide the total draught required by the draught produced; the quotient of which, multiplied by the second driving wheel, will give the second driven-wheel; if more wheels are required, they will be found in the same way.

N. B.—The second driving, or change-wheel may contain any number of teeth, according to the diameter required.

If larger or smaller wheels be required, they may be increased, or decreased, in proportion to each other, *i. e.*, the driving and driven-wheels must be multiplied, or divided by the same number.

If the back roller be 1 inch, and the front roller $1\frac{1}{8}$ inch diameter; what wheels will be required to produce a draught of 6?

Diameter of front roller, 9, or $1\frac{1}{8}$ inches.
3

First-driving wheel, 27 teeth.

Diameter of back roller, 8, or 1 inch.
$3 \times 2 = 6$

First-driven wheel, 48 teeth.

Driving-wheel. Driven-wheel.
27 teeth. 48 teeth.
Back roller, 1 inch, or 8 9, or $1\frac{1}{8}$ inch, front roller.

216)432(2 draught.
432

2)6 total draught.

3
2d dving. or change-whl., 24 teeth.

2d driven-wheel, 72 teeth.

The draught is required from the following particulars:—

Driving-wheels, 27, and 24. Driven-wheels, 48, and 72.
Diameter of back roller, 1 inch, and front roller, $1\frac{1}{8}$, or $\frac{9}{8}$ inch.

Driving-wheels. Driven-wheels.
27 teeth. 48 teeth.
24 teeth. 72 teeth.

108 96
54 336

648 3456
Diam. back rol., 1 in., or 8 9, or $1\frac{1}{8}$ inch, diam. front rol.

5184)31104(6 draught required.
31104

Note.—Speeds, draughts, &c., may be wrought with fewer figures by the following method of cancelling, viz., place all the driven-wheels and the diameter of the front rollers as numerators, and all the driving-wheels and the diameter of the back rollers as denominators; then proceed by dividing with any number that will divide both numerator and denominator without any remainder, and the results of the numerators multiplied together for a dividend, and the results of the denominators for a divisor, and the quotient will be the answer required.

If the driving-wheels are 27, and 24, and the diameter of the back roller 1 inch, and the driven-wheels are 48, and 72, and the diameter of the front roller $1\frac{1}{8}$ inch; what will the draught be?

$$\frac{\overset{6}{\cancel{48}}}{\underset{\cancel{9}}{\cancel{27}}} \times \frac{\overset{\cancel{3}}{\cancel{72}}}{\cancel{24}} \times \frac{\cancel{9}}{\cancel{8}} = \frac{6}{1}$$ 6 or 6 draught.

If the back roller be $\frac{7}{8}$ inch, and the front roller 1 inch diameter; what wheels will be required to produce a draught of $5\frac{1}{2}$?

$$\frac{\text{Diameter of front roller, } 8\text{, or 1 inch.}}{\overset{\cancel{3}}{}\;\text{First driving-wheel } 24 \text{ teeth.}}$$

$$\frac{\text{Diameter of the back roller } 7\text{, or } \tfrac{7}{8} \text{ inch.}}{3 \times 2 = 6 \;\; \text{First driven-wheel, } 42 \text{ teeth.}}$$

	Driving-wheel.	Driven-wheel.
	24 teeth.	42 teeth.
Back roller, $\frac{7}{8}$ inch, or	7	8, or 1 inch, front roller.
	168	)336(2 draught.
		336

2)5.5 total draught.

2.75
2d driving, or change-wheel, 28 teeth.

2200
550

2d driven-wheel 77.00 teeth.

If the driving-wheels be 24, and 28, the diameter of the back roller $\frac{7}{8}$ inch, and the driven-wheels 42, and 77, and the diameter of the front roller 1 inch, what will the draught be?

Driving-wheels.	Driven-wheels.
24 teeth.	42 teeth.
28 teeth.	77 teeth.
192	294
48	294
672	3234
Back roller, $\frac{7}{8}$ inch, or 7	8, or 1 inch, front roller.
4704	)25872(5.5, or $5\frac{1}{2}$ draught.
	23520
	23520
	23520

If the back roller be $\frac{7}{8}$ inch, and the front roller 1 inch diameter; what wheels will be required to produce a draught of $2\frac{1}{3}$ in the first driving and driven-wheels, and a total draught of 7?

Diameter of front roller, 8, or 1 inch.
3

First driving-wheel, 24 teeth.

Diameter of back roller, 7, or $\frac{7}{8}$ inch.
3 × 2 = 6

42
Add 21 divided by 3 = 7

First driven-wheel, 49 teeth

Driving-wheel. Driven-wheel.
24 teeth. 49 teeth.
Back roller, $\frac{7}{8}$ inch, or 7 8, or 1 inch, front roller.

168)392(2$\frac{1}{3}$ draught.
336

56

$\frac{56}{168}=\frac{1}{3}$

2$\frac{1}{3}$ draught. 7, total draught.
3 3

7 7)21

3
21 second driving or change-wheel.

63 second driven-wheel.

If the driving-wheels be 24, and 21, and the driven-wheels 49, and 63, the back roller $\frac{7}{8}$ inch, and the front roller 1 inch diameter; what will the draught be?

Driving-wheels. Driven-wheels.
24 teeth. 49 teeth.
21 teeth. 63 teeth.

24 147
48 294

504 3087
Back roller, $\frac{7}{8}$ inch, or 7 8, or 1 inch, front roller.

3528)24696(7 draught.
24696

If the diameter of the front roller be 1$\frac{1}{8}$ inch, and the back roller 1 inch; what wheels will be required to produce a draught of 4$\frac{1}{2}$?

Diameter of the front roller, 9, or 1$\frac{1}{8}$ inch.
2

First driving-wheel 18 teeth.

Diameter of back roller, 8, or 1 inch.
2 × 2 = 4

First driven-wheel, 32 teeth.

	Driving-wheel.	Driven-wheel.
	18 teeth.	32 teeth.
Back roller, 1 inch, or	8	9, or 1⅛ inch, front roller.
	144	)288(2 draught.
		288

2)4.5 total draught.
2.25
2d driving-wheel, 28 teeth.
1800
450

2d driven-wheel, 63 teeth.

The draught in rollers is required, when the driving-wheels are 18, and 28, and the driven wheels 32, and 63, and the diameter of the back roller 1 inch, and front roller 1⅛ inch.

	Driving-wheels.	Driven-wheels.
	18 teeth.	32 teeth.
	28	63
	144	96
	36	192
	504	2016
Back roller, 1 inch, or	8	9, or 1⅛ inch front roller.
	4032	)18144(4.5, or 4½ draught.
		16128
		20160
		20160

What wheels will be required to produce $7\frac{1}{2}$ draught, if the back roller be 1 inch diameter, and the front roller $1\frac{1}{8}$ inch?

Diameter of front roller, $1\frac{1}{8}$ inch, = 9
3
—
First driving-wheel, 27 teeth.

Diameter of back roller, 1 inch, or 8
$3 \times 2 = 6$
—
48
Add 24 divided by 2 for one-half = 12
—
First driven-wheel, 60 teeth.

Driving-wheel. Driven-wheel.
27 teeth. 60 teeth.
Diam. of back rol. 1 in., or 8 9, or $1\frac{1}{8}$ in. diam. of front rol.
216)540(2.5, or $2\frac{1}{2}$ draught.
432
1080
1080

$7\frac{1}{2}$ is the total draught required, which must be divided by $2\frac{1}{2}$ the first draught; the quotient of which multiplied by the second driving or change-wheel, will give the second driven-wheel.

Thus,

2.5)7.5(3 multiplied by wheel 26 teeth, will
75 be equal to 78 teeth, wheel 2d
— driven.

The draught in rollers, is required from the following particulars:—

Driving-wheels, 27, and 26 teeth. Driven-wheels, 60, and 78 tth. Back roller, 1 inch diameter; and front roller, $1\frac{1}{8}$ inch.

Driving-wheels.	Driven-wheels.
27 teeth.	60 teeth.
26 teeth.	78 teeth.
162	4680
54	9, or 1⅛ inch, front rol.
702	42120 dividend.
Bk. rol. 1 in., or 8	
5616 divisor.	

5616)42120(7.5, or 7½ draught.
39312

28080
28080

Or,

BY CANCELLING.

$$\frac{\overset{15}{\cancel{60}}}{\underset{\cancel{9}}{\cancel{27}}} \quad \frac{\overset{\cancel{3}}{\cancel{78}}}{\cancel{26}} \quad \frac{\cancel{9}}{\underset{2}{\cancel{8}}} = \frac{15}{2} = 7\tfrac{1}{2} \text{ draught.}$$

If the diameter of the front roller be 1 inch, and the back roller ⅞ inch; what wheels will be required to produce a draught of 8?

Diameter of front roller, 1 inch, or 8
3

First driving-wheel, 24 teeth.

Diameter of back roller, ⅞ inch, or 7
3 × 2 = 6

First driven-wheel, 42 teeth.

Driving-wheel. Driven-wheel.
24 teeth. 42 teeth.
Back roller, $\frac{7}{8}$ inch, or 7 8, or 1 inch, front roller.

168)336(2d draught.
336

2)8 total draught.

4
2d driving-wheel, 20 teeth.

2d driven-wheel, 80 teeth.

If the driving-wheels be 24, and 30, and the driven-wheels 42, and 80, the back roller $\frac{7}{8}$ inch diameter, and the front roller 1 inch; what will the draught be?

Driving-wheels. Driven-wheels.
24 teeth. 42 teeth.
20 teeth. 80 teeth.

480 3360
Diam. of bk. rol., $\frac{7}{8}$ in., or 7 8, or 1 in. diam. of front rol.

3360)26880(8 draught at rollers.
26880

If the diameter of the back roller be $\frac{7}{8}$ inch, and the front roller 1 inch; what wheels will be required to produce a draught of 9, *i. e.*, 1 into 9?

Diameter of front roller, 8, or 1 inch.
3

1st driving-wheel, 24 teeth.

Diameter of back roller, 7, or $\frac{7}{8}$ inch.
3 × 2 = 6

42
Add 21 divided by 3 = 7

1st driven-wheel, 49 teeth.

	Driving-wheel.	Driven-wheel.
	24 teeth.	49 teeth.
Back rollers, $\frac{7}{8}$ inch, or	7	8, or 1 inch front roller.
	168	)392($2\frac{1}{3}$ draught.
		336
		56

$$\frac{56}{168} = \frac{1}{3}.$$

$2\frac{1}{3}$ draught	9 total draught.
3	3
7	7)27
	$3\frac{6}{7}$

2d driving-wheel, 21 teeth.

2d driven-wheel, 81 teeth.

The draught in rollers, is required from the following particulars:—

Driving-wheels, 24, and 21 teeth. Diameter of back roller, $\frac{7}{8}$ inch.
Driven-wheels, 49, and 81 teeth. Diameter of front roller, 1 inch.

	Driving-wheels.	Driven-wheels.
	24 teeth.	49 teeth.
	21 teeth.	81 teeth.
	24	49
	48	392
	504	3969
Back roller, $\frac{7}{8}$ inch, or	7	8, or 1 inch, front roller.
	3528	)31752(9 draught.
		31752

If the diameter of the back roller be 1 inch, and the front roller $1\frac{1}{8}$ inch, what wheels will be required to produce a draught of $2\frac{1}{4}$, between the first driving and driven-wheels, and a total draught of 8.4375?

Diameter of front roller, 9, or $1\frac{1}{8}$ inch.
3

1st driving-wheel, 27 teeth.

Diameter of back roller, 8, or 1 inch.
3 × 2 = 6

48
Add 24 divided by 4 = 6

1st driven-wheel, 54 teeth.

Driving-wheels. Driven-wheels.
27 teeth. 54 teeth.
Diam. back rol., 1 in., = 8 9, or $1\frac{1}{8}$ inch, front roller.

Divisor 216 486 dividend.

216)486(2.25, or $2\frac{1}{4}$ draught, between the first driving and driven-wheels.
432

540
432

1080
1080

Draught required.
1st draught, 2.25)8.4375(3.75 = 2d draught.
675

1687
1575

1125
1125

3.75, 2d draught.
2d driving, or change-wheel, 24 teeth.

1500
750

90.00 2d driven wheel, 90 teeth.

The draught in rollers is required from the following particulars:—

Driving-wheels, 27, and 24 teeth. Diameter of back roller, 1 inch.
Driven-wheels 54, and 90 teeth. Diameter of front roller 1⅛ inch.

Driving-wheels.	Driven-wheels.
27 teeth.	54 teeth.
24 teeth.	90 teeth.

108 4860
54 9, or 1⅛ inch, front roller.

648 43740 dividend.
Back rollers, 1 inch, or 8

5184 divisor.

5184)43740(8.4375 draught required.
41472

22680
20736

19440
15552

38880
36288

25920
25920

If 5⅓ hank roving produces No. 45's twist, what will the total draught at the mules be?

Hank roving, $5\frac{1}{3}$ 45's No. of twist.
3 3

16)135(8.4375 draught required at the mules.
128

70
64 120
112

60
48 80
80

N. B.—When there are any fractional parts in the divisor, or dividend, reduce them to the same name as in the last example.

If the diameter of the back roller be $\frac{7}{8}$ inch, and the front roller 1 inch, what wheels will be required to produce a draught of $10\frac{2}{3}$, or 10,666; the draught between the first driving and driven-wheels to be $2\frac{2}{3}$, or 2.666.

Diam. of front rol., 1 inch, or 8. Diam. of bk. rol. $\frac{7}{8}$ inch, or 7
3 $3 \times 2 = 6$

1st driving-wheel, 24 teeth. 42
Add $\frac{2}{3}$ of $21 = 14$

1st driven-wheel, 56 tth.

Driving-wheel. Driven-wheel.
24 teeth. 56 teeth.
Back roller $\frac{7}{8}$ inch, or 7 8, or 1 inch front roller.

168)448(2.66, first draught.
336

1120
1008

1120
1008

112

Draught required.
1st draught, 2.66)10.66(4, 2d draught.
1066
2d driving, or change-wheel, 22 teeth.
4, 2d draught.

2d driven-wheel, 88 teeth.

The draught between the back and front rollers of a throstle, is required from the following particulars:—

Driving-wheels, 24, and 22 teeth.
Driven-wheels, 56, and 88 teeth.
Diameter of back roller, $\frac{7}{8}$ inch.
Diameter of front roller, 1 inch.

	Driving-wheels.	Driven-wheels.
	24 teeth.	56 teeth.
	22 teeth.	88 teeth.
	48	448
	48	448
	528	4928
Back roller, $\frac{7}{8}$ inch, or	7	8, or 1 inch, front roller.
	3696	)39424(10.66, or $10\frac{2}{3}$, draught between back and front rollers of the throstle.
		3696
		24640
		22176
		24640
		22176
		2464

EXPLANATION TO THE REED TABLE.

1. Manchester and Stockport count by the number of ends in 1 inch.
2. Bolton counts by the number of beers on $24\frac{1}{4}$ inches, 20 dents to a beer.
3. Blackburn counts by the number of beers on 45 inches, 20 dents to a beer.

4. 6-4ths Preston counts by the number of beers on 58 inches, 20 dents to a beer.
5. 9-8ths Preston counts by the number of beers on 44 inches, 20 dents to a beer.
6. 4-4ths Preston counts by the number of beers on 39 inches, 20 dents to a beer.
7. 7-8ths Preston counts by the number of beers on 34 inches, 20 dents to a beer.
8. Nankeen counts by the number of beers on 20 inches, 19 dents to a beer.
9. Scotch and Carlisle count by the number of dents on 37 inches.
10. Silk counts by the number of ends on 36 inches.
11. Number of dents in 1 yard.
12. The United States of America, the number of splits or dents in a reed 36 inches wide, indicates the count of cloth in the States of Pennsylvania, New Jersey and Delaware, and throughout nearly all the States for all twilled goods, but plain goods are counted by the number of *threads* on an inch, each split or dent containing 2 threads. For instance,

    If we wish to determine the count of any particular plain goods, we count the number of threads on an inch, and that number multiplied by 36, and divided by 2, gives you the reed on which the goods were woven.

    In setting print cloths, the number of threads on an inch are taken as the count, viz. If you have cloth woven in a 1200 reed, you multiply the count of the reed by 2, which will make 2400, and that divided by 36 will be 66, which will designate the count of that particular kind of goods. Throughout New England generally, the above count is used for all plain goods, and the number of dents in a reed for twilled.

The first line in each division is the number of dents in 1 inch; opposite to which is the count of the reed, according to the system of counting.

N. B.—A dent is generally called a split in Scotland; a beer is generally called a porter in Scotland.

Bleached or finished goods generally decrease in width about 10 per cent.

REED TABLE.

1		2		3		4		5	
United States.		Bolton.		Blackburn.		6-4ths. Preston.		9-8ths. Preston.	
N. of dts. in 1 in.	count of reed.	N. of dts. in 1 in.	count of reed.	N. of dts. in 1 in.	count of reed.	N. of dts. in 1 in.	count of reed.	N. of dts. in 1 in.	count of reed.
15	30	15	18.187	15	33.75	15	43.5	15	33.
16	32	16	19.4	16	36.	16	46.4	16	35.2
17	34	17	20.612	17	38.25	17	49.3	17	37.4
18	36	18	21.825	18	40.5	18	52.2	18	39.6
19	38	19	23.037	19	42.75	19	55.1	19	41.8
20	40	20	24.25	20	45.	20	58.	20	44.
21	42	21	25.462	21	47.25	21	60.9	21	46.2
22	44	22	26.675	22	49.5	22	63.8	22	48.4
23	46	23	27.887	23	51.75	23	66.7	23	50.6
24	48	24	29.1	24	54.	24	69.6	24	52.8
25	50	25	30.31	25	56.25	25	72.5	25	55.
26	52	26	31.52	26	58.5	26	75.4	26	57.2
27	54	27	32.73	27	60.75	27	78.3	27	59.4
28	56	28	33.95	28	63.	28	81.2	28	61.6
29	58	29	35.16	29	65.25	29	84.1	29	63.8
30	60	30	36.87	30	67.5	30	87.	30	66.
31	62	31	37.58	31	69.75	31	89.9	31	68.2
32	64	32	38.8	32	72.	32	92.8	32	70.4
33	66	33	40.1	33	74.25	33	95.7	33	72 6
34	68	34	41.22	34	76.5	34	98.6	34	74.8
35	70	35	42.43	35	78.75	35	101.5	35	77.
36	72	36	43.65	36	81.	36	104.4	36	79.2
37	74	37	44.86	37	83.25	37	107.3	37	81.4
38	76	38	46.07	38	85.5	38	110.2	38	83.6
39	78	39	47.28	39	87.75	39	113.1	39	85.8
40	80	40	48.5	40	90.	40	116.	40	88.
41	82	41	49.71	41	92.25	41	118.9	41	90.2
42	84	42	50.9	42	94.5	42	121.8	42	92.4
43	86	43	52.13	43	96.75	43	124.7	43	94.6
44	88	44	53.35	44	99.	44	127.6	44	96.8

REED TABLE.

6		7		8		9		10		11
4-4ths. Preston.		7-8ths. Preston.		Nankeen.		Scotch.		Silk.		
N. of dts. in 1 in.	count of reed.	N. of dts. in 1 in.	count of reed.	N. of dts. in 1 in.	count of reed.	N. of dts. in 1 in.	count of reed.	N. of dts. in 1 in.	count of reed.	N. of dts. in 1 yard.
15	29.25	15	25.5	15	15.79	15	555	15	1080	540
16	31.2	16	27.2	16	16.842	16	592	16	1152	576
17	33.15	17	28.9	17	17.894	17	629	17	1224	612
18	35.1	18	30.6	18	18.947	18	666	18	1296	648
19	37.05	19	32.3	19	20.	19	703	19	1368	684
20	39.	20	34.	20	21.052	20	740	20	1440	720
21	40.95	21	35.7	21	22.105	21	777	21	1512	756
22	42.9	22	37.4	22	23.157	22	814	22	1584	792
23	44.85	23	39.1	23	24.21	23	851	23	1656	828
24	46.8	24	40.8	24	25.26	24	888	24	1728	864
25	48.75	25	42.5	25	26.31	25	925	25	1800	900
26	50.7	26	44.2	26	27.36	26	962	26	1872	936
27	52.65	27	45.9	27	28.42	27	299	27	1944	972
28	54.6	28	47.6	28	29.47	28	1036	28	2016	1008
29	56.55	29	49.3	29	30.52	29	1073	29	2088	1044
30	58.5	30	51.	30	31.57	30	1110	30	2160	1080
31	60.45	31	52.7	31	32.63	31	1147	31	2232	1116
32	62.4	32	54.4	32	33.68	32	1184	32	2304	1152
33	64.35	33	56.1	33	34.73	33	1221	33	2376	1188
34	66.3	34	57.8	34	35.79	34	1258	34	2448	1224
35	68.25	35	59.5	35	36.84	35	1295	35	2520	1260
36	70.2	36	61.2	36	37.89	36	1332	36	2592	1296
37	72.15	37	62.9	37	38.94	37	1369	37	2664	1332
38	74.1	38	64.6	38	40.	38	1406	38	2736	1368
39	76.05	39	66.3	39	41.05	39	1443	39	2808	1404
40	78.	40	68.	40	42.1	40	1480	40	2880	1440
41	79.95	41	69.7	41	43.15	41	1517	41	2952	1476
42	81.9	42	71.4	42	44.21	42	1554	42	3024	1512
43	83.85	43	73.1	43	45.26	43	1591	43	3096	1548
44	85.8	44	74.8	44	46.31	44	1628	44	3168	1584

THE DIFFERENT SYSTEMS OF COUNTING REEDS.

If there be 21 dents in an inch; what count of reed will it be in Manchester or Stockport?

21 dents in an inch.
2 ends in a dent.

42 count of reed.

If there be 26 dents in an inch, what count of reed will it be in Bolton, allowing 20 dents to a beer.

24.25 inches.
26 dents in an inch.

14550
4850

Dents in a beer, 2.0)63.0.50

31.525 count of reed.

If there be 26 dents in an inch, what count of reed will it be in Bolton, allowing 19 dents to a beer?

24.25 inches.
26 dents in an inch.

14550
4850

Dents in a beer, 19)630.50(33.1842 count of reed.
57

60
57

35
19

160
152

80
76

40
38

2

Suppose a reed contains 33 dents in 1 inch, what count will it be according to the different systems of counting?

UNITED STATES, MANCHESTER, AND STOCKPORT.

Multiply the number of dents in 1 inch by 2, and the product will be the count of the reed.

33 number of dents in 1 inch.
2 ends in a dent.
66 count of reed.

BOLTON COUNT, 20 DENTS TO A BEER.

Multiply 24¼ by the number of dents in 1 inch, and divide by 20, and the quotient will be the count of the reed.

24.25 inches.
33 number of dents in 1 inch.
7275
7275
Number of dents in a beer, 2.0)80.0.25
40.0125 count of reed.

BOLTON COUNT, 19 DENTS TO A BEER.

Multiply 24¼ by the number of dents in 1 inch, and divide by 19, and the quotient will be the count of the reed.

24.25 inches.
33 dents in 1 inch.
7275
7275
Dents in a beer, 19)800.25(42.12 count of reed.
76
40
38
22
19 35
38—nearly.

N.B.—Some kinds of goods manufactured in Bolton, reckon 19 *dents to a beer.*

REED TABLE.

1		2		3		4		5	
United States.		Bolton.		Blackburn.		6-4ths Preston.		6-4ths Preston.	
N. of dts. in 1 in.	count of reed.	N. of dts. in 1 in.	count of reed.	N. of dts. in 1 in.	count of reed.	N. of dts. in 1 in.	count of reed.	N. of dts. in 1 in.	count of reed.
45	90	45	54.56	45	101.25	45	130.5	45	99.
46	92	46	55.71	46	103.5	46	133.4	46	101.2
47	94	47	56.98	47	105.75	47	136.3	47	103.4
48	96	48	58.2	48	108.	48	139.2	48	105.6
49	98	49	59.41	49	110.25	49	142.1	49	107.8
50	100	50	60.62	50	112.5	50	145.	50	110.
51	102	51	61.83	51	114.75	51	148.9	51	112.2
52	104	52	63.04	52	117.	52	151.8	52	114.4
53	106	53	64.25	53	119.25	53	154.7	53	116.6
54	108	54	65.46	54	121.5	54	157.6	54	118.8
55	110	55	66.687	55	123.75	55	159.5	55	121.
56	112	56	67.9	56	126.	56	162.4	56	123.2
57	114	57	69.112	57	128.25	57	165.3	57	125.4
58	116	58	70.325	58	130.5	58	168.2	58	127.6
59	118	59	71.537	59	132.75	59	171.1	59	129.8
60	120	60	72.75	60	135.	60	174.	60	132.
61	122	61	73.962	61	137.25	61	176.9	61	134.2
62	124	62	75.175	62	139.5	62	179.8	62	136.4
63	126	63	76.387	63	141.75	63	182.7	63	138.6
64	128	64	77.6	64	144.	64	185.6	64	140.8
65	130	65	78.812	65	146.25	65	188.5	65	143.
66	132	66	80.025	66	148.5	66	191.4	66	145.2
67	134	67	81.237	67	150.75	67	194.3	67	147.4
68	136	68	82.45	68	153.	68	197.2	68	149.6
69	138	69	83.662	69	155.25	69	200.1	69	151.8
70	140	70	84.875	70	157.5	70	203.	70	154.
71	142	71	86.087	71	159.75	71	205.9	71	156.2
72	144	72	87.3	72	162.	72	208.8	72	158.4
73	146	73	88.512	73	164.25	73	211.7	73	160.6
74	148	74	89.725	74	166.5	74	214.6	74	162.8

REED TABLE.

6		7		8		9		10		11
4-4ths Preston.		7-8ths Preston.		Nankeen.		Scotch.		Silk.		
N. of dts. in 1 in.	count of reed.	N. of dts. in 1 in.	count of reed.	N. of dts. in 1 in.	count of reed.	N. of dts. in 1 in.	count of reed.	N. of dts. in 1 in.	count of reed.	N. of dts. in 1 yd.
45	87.75	45	76.5	45	47.36	45	1665	45	3240	1620
46	89.7	46	78.2	46	48.42	46	1702	46	3312	1656
47	91.65	47	79.9	47	49.47	47	1739	47	3384	1692
48	93.6	48	81.6	48	50.52	48	1776	48	3456	1728
49	95.55	49	83.3	49	51.57	49	1813	49	3528	1764
50	97.5	50	85.	50	52.63	50	1850	50	3600	1800
51	99.45	51	86.7	51	53.67	51	1887	51	3672	1836
52	101.4	52	88.4	52	54.72	52	1924	52	3744	1872
53	103.35	53	90.1	53	55.78	53	1961	53	3816	1908
54	105.3	54	91.8	54	56.84	54	1998	54	3888	1944
55	107.25	55	93.5	55	57.894	55	2035	55	3960	1980
56	109.2	56	95.2	56	58.947	56	2072	56	4032	2016
57	111.15	57	96.9	57	60.	57	2109	57	4104	2052
58	113.1	58	98.6	58	61.052	58	2146	58	4176	2088
59	115.05	59	100.3	59	62.105	59	2183	59	4248	2124
60	117.	60	102.	60	63.158	60	2220	60	4320	2160
61	118.95	61	103.7	61	64.21	61	2257	61	4392	2196
62	120.9	62	105.4	62	65.263	62	2294	62	4464	2232
63	122.85	63	107.1	63	66.316	63	2331	63	4536	2268
64	124.8	64	108.8	64	67.368	64	2368	64	4608	2304
65	126.75	65	110.5	65	68.421	65	2405	65	4680	2340
66	128.7	66	112.2	66	69.473	66	2442	66	4752	2376
67	130.65	67	113.9	67	70.526	67	2479	67	4824	2412
68	132.6	68	115.6	68	71.579	68	2516	68	4896	2448
69	134.55	69	117.3	69	72.631	69	2553	69	4968	2484
70	136.5	70	119.	70	73.684	70	2590	70	5040	2520
71	138.45	71	120.7	71	74.737	71	2627	71	5112	2556
72	140.4	72	122.4	72	75.789	72	2664	72	5184	2592
73	142.35	73	124.1	73	76.842	73	2701	73	5256	2628
74	144.3	74	125.8	74	77.894	74	2738	74	5328	2664

BLACKBURN COUNT, 20 DENTS TO A BEER.

Multiply 45 by the number of dents in an inch, and divide by the number of dents in a beer, and the quotient will be the count of the reed.

45 inches.
33 dents in an inch.

135
135

Dents in a beer, 2.0)148.5

74.25 count of reed.

PRESTON 6-4ths COUNT, 20 DENTS TO A BEER.

Multiply 58 by the number of dents in an inch, and divide by 20, and the quotient will be the count of the reed.

58 inches.
33 dents in an inch.

174
174

Dents in a beer, 2.0)191.4

95.7 count of reed.

PRESTON 9-8ths COUNT, 20 DENTS TO A BEER.

44 inches.
33 dents in an inch.

132
132

Dents in a beer, 20)1452(72.6
140

52
40

120
120

N.B.—Some manufacturers in Oldham count same as Blackburn for fustians and velvets; printing cloths are same as Manchester.

PRESTON 4-4ths, OR YARD WIDE COUNT, 20 DENTS TO A BEER.

Multiply 39 by the number of dents in an inch, and divide by the number of dents in a beer, and the quotient will be the count of the reed.

39 inches.
33 dents in an inch.

117
117

Dents in a beer, 2.0)128.7

64.35 count of reed.

PRESTON 7-8ths COUNT, 20 DENTS TO A BEER.

Multiply 34 by the number of dents in an inch, and divide by the number of dents in a beer, and the quotient will be the count of the reed.

34 inches.
33 dents in an inch.

102
102

Dents in a beer, 2.0)112.2

56.1 count of reed.

NANKEEN COUNT, 19 DENTS TO A BEER.

Multiply 20 by the number of dents in an inch, and divide by the number of dents in a beer, and the quotient will be the count of the reed.

20 inches.
33 dents in an inch.

660

Dents in a beer, 19)660(34.73, or nearly $34\frac{3}{4}$, count of reed.
57
90
76
140
133
70
57
13

SCOTCH AND CARLISLE COUNT.

Multiply 37 by the number of dents in an inch, and the product will be the count of the reed.

37 inches.
33 dents in an inch.
111
111
1221 count of reed.

SILK COUNT.

Multiply 36 by the number of dents in an inch, and that product by 2, which will be the count of the reed.

36 inches.
33 dents in an inch.
108
108
1188
2 ends in a dent.
2376 count of reed.

NUMBER OF DENTS IN A YARD.

Multiply the number of dents in an inch by the number of inches in a yard, and the product will be the number of dents in a yard.

```
  33 dents in an inch.
  36 inches in a yard.
 ----
 198
 99
 ----
1188 dents in a yard.
```

Some manufacturers count calicoes, checks, and handkerchiefs, by the number of beers in a yard, some 19, and some 20 dents to a beer.

By 20 dents to a beer.

```
                       36 inches 1 yard.
                       33 dents in an inch.
                      ----
                      108
                     108
                     ----
Dents in a beer, 2.0)118.8
                    -----
                      59.4 count of reed.
```

By 19 dents to a beer.

```
                     36 inches 1 yard.
                     33 dents in an inch.
                    ----
                    108
                   108
                   ----
Dents in a beer, 19)1188(62.526 count of reed.
                    114
                    ----
                     48
                     38
                     ----
                     100
                      95
                     ----       120
                        50      114
                        38      ----
                       ----       6
```

Some manufacturers of fustians, velvets, velveteens, velveretts, satteens, &c., count by the number of beers set on 24 inches at the reed, some 20, and some 19 dents to a beer.

```
                          24 inches.
                          33 dents in an inch.
                        ----
                          72
                         72
                        ----
Dents in a beer, 2.0)79.2
                        ----
                        39.6 count of reed.
```

If there be 33 dents in an inch, how many beers, 19 dents to a beer, will there be in 24 inches?

```
                          33 dents in an inch.
                          24 inches.
                        ----
                         132
                         66
                        ----
Dents in a beer, 19)792(41.684 count of reed.
                    76
                    ---
                     32
                     19
                     ---
                     130
                     114
                      ---
                      160
                      152
                       ---
                        80
                        76
                        ---
                         4
```

How many dents will there be in an inch, in a 6-4ths 145 Preston reed?

Multiply the count of the reed by the number of dents in a beer, and divide by the number of inches any given number of beers is set on, and the quotient will be the number of dents in an inch.

$$\begin{array}{rl} & 145 \text{ count of reed.} \\ & \quad 20 \text{ dents to a beer.} \\ \hline \text{Inches set on, } 58) & 2900(50, \text{ number of dents in an inch.} \\ & 290 \\ \hline & \quad\;\; 0 \end{array}$$

Whatever the count of the reed, or system of counting may be, by referring to the table, you will find the number of dents in an inch.

The number of dents in an inch multiplied by 2, and that product multiplied by the number of inches intended to be filled at the reed, will give the number of ends required in the warp, for any kind of plain goods.

MANUFACTURING.

Rules and examples for ascertaining the weight of warp and weft, required for the manufacture of any description of cotton goods, according to the length and width of the piece, and the fineness of yarns.

On account of some kind of goods requiring to be laid a greater length on the warping mill than others, it will be found the most accurate to ascertain the length and weight of twist required for the warp, and divide by the number of cuts or pieces in the warp, which will give the length and weight of twist (according to its fineness) required for one cut, or piece of cloth.

N. B.—The general allowance for waste, is about 1-50*th of the weight of weft required to weave the piece.*

TO ASCERTAIN THE WEIGHT OF A WARP.

RULE.—Multiply the length of the warp by the width in inches required at the reed, and that product by the number of ends in an inch, for a dividend. Then multiply the number of yards in one hank by the number of hanks in the pound of twist for a divisor, and the quotient will be the weight of the warp.

N. B.—By referring to the reed table, the number of ends in an inch of any reed may be found, according to the system of counting.

Required, the weight of number 36's twist, for a warp 146 yards long, 29 inches wide at the reed, and 72 ends in an inch?

146 yards, length of warp.
29 inches, width at reed.

1314
292

4234
72 ends in an inch.

8468
29638

Dividend, 304848 yards of twist in the warp.

840 yards, 1 hank.
36 hanks in 1 lb.

5040
2520

Divisor, 30240 yards in 1 lb. of 36's twist.

30240)304848(10 lbs., $1\frac{1}{4}$ oz. weight of warp.
30240

2448
16 oz. =1 lb.

14688
2448

39168

30240)39168(1 ounce.
30240

8928
4 qrs., 1 oz.

30240)35712(1 qr.
30240

5472

The weight of warp or weft may be found in a much easier way, by dividing the number of yards of twist, or weft required, by the number of yards in 1 ounce, which will be found in the yarn table according to the fineness of the yarns, as in the following example:—

Required, the weight of 36's twist, for a warp 146 yards long, 29 inches wide at the reed, and 72 ends in an inch?

146 yards, length of warp.
29 inches, width of warp at reed.

1314
292

4234
72 ends in an inch.

8468
29638

Dividend, 304848 yards in warp.

Yards in 1 oz. of 36's twist, 1890)304848(161¼ oz., or 10 lbs.,
1890 1¼ oz., wt. of warp.

11584
11340

2448
1890

558
4 qrs., 1 oz.

1890)2232(1 qr.
1890
342

If there be 304848 yards of 36's twist, in a warp containing 5 cuts or pieces; what weight of twist will there be in 1 piece?

Cuts, or pieces in warp, 5)304848 yards of twist in warp.

Yds. in 1 oz. of 36's twist, 1890)60969.6(32¼ oz., or 2 lbs., 0¼ oz., wt. of twist required for 1 piece of cloth.
5670
4269
3780
489.6
4 qrs., 1 oz.
1890)1958.4(1 qr.
1890
68.4

Required, the weight of number 36's weft, to weave a piece of cloth 30 yards long, 29 inches wide, and 84 threads, or picks in an inch, allowing 1-40th for waste?

30 yards, length of piece.
29 inches, width of piece.
870
84 threads or picks in an inch.
3480
6960
73080
Allowance for waste, 1-40 1827
Dividend, 74907 yards required to weave a piece.

Yards in 1 ounce, 1890)74907(39½ oz., or 2 lbs., 7½ oz., weight of weft required to weave a piece of cloth.
5670

18207
17010

1197
4 qrs., 1 oz.

1890)4788(2 qrs.
3780

1008

Or Thus,

1 lea is 12.0 yds.)7490.7 yards of weft required to weave a piece.

1 hank, 7 leas)624.225

Nos. of weft, 36's { 6)89.175 hanks, or 2 lbs., 7½ oz., weight of weft required.
6)14.8625

2.477083 lbs.
16 oz., 1 lb.

2862500
477083

7.633333 oz.
4 qrs., 1 oz.

2.533333 qrs.

Or Thus,

840 yards, 1 hank.
36 hanks, 1 lb.

5040
2520

Divisor, 30240 yards in 1 lb. of 36's weft.

Yards.
30240)74907(2 lbs. 7½ oz., weight of weft required.
60480

14427
16

86562
14427

30240)230832(7½
211680

19152

Required, the weight of number 60's twist, for a warp 146 yards long, 39 inches wide, and 106 ends to an inch?

146 yards, length of warp.
39 inches, width at the reed.

1314
438

5694
106 ends in an inch.

34164
56940

1 lea, 12.0 yards)60356.4 yards of twist in warp.

1 hank is 7 leas)5029.7 leas of twist in warp.

Numbers of twist 6.0)71.8.52857 hanks of twist in warp.

11.9754761 lbs. of twist in warp.
16 ounces, 1 lb.

58528566
9754761

15.6076176 ounces.
4 qrs., 1 oz.

2.4304704 qrs.

The weight of twist required for the warp, is 11 lbs., 15½ oz.

If there be 603564 yards of number 60's twist in a warp; what will it weigh?

Yards in 1 ounce of 60's twist, 3150)603564(191½ ounces, or 11 pounds, 15½ oz., weight of warp.
3150
28856
28350
5064
3150
1914
4 qrs., 1 oz.
3150)7656(2 qrs.
6300
1356

If a warp, 146 yards long, 39 inches wide, and 106 ends in an inch, weigh 12 lbs., what numbers of twist will it be?

146 yards, length of warp.
39 inches, width of warp at reed.
1314
438
5694
106 ends in an inch.
34164
56940
Wt. of warp 12 lbs.)603564 number of yards in a warp.
50297

1 hank is 840 yards)50297(59.87 nearly, number 60's twist.
4200

8297
7560

7370
6720

6500
5880

620

What length and weight of number 80's weft, will it require to weave a warp 146 yards long, 39 inches wide at the reed, and 120 threads, or picks in an inch, allowing 1-50th for waste?

146 yards, length of warp.
120 threads, or picks in an inch.

17520
39 inches, width at reed.

157680
52560

683280
Add 1-50th for waste 13665.6

696945.6 yards required to weave the warp.

1 lea is 12.0 yds.)69694.5.6 yds. of weft required to weave a piece.

1 hank is 7 leas.)5807.88 leas of do.

829.69714 hanks.
7 leas, 1 hank.

4.87998 leas.
120 yards, 1 lea.

105.59760 yards.

The length of weft required to weave the warp will be 829 hanks, 4 leas, and $105\frac{3}{5}$ yards.

Numbers of weft, 8.0)82.9.69714 hanks of 80's weft.

10.371214 lbs.
16 ounces, 1 lb.

2227284
371214

5.939424 oz.
4 qrs., 1 oz.

3.757696 qrs.

10 lbs. $5\frac{3}{4}$ oz., nearly 10 lbs., 6 oz. weight of 80's weft, required to weave the warp.

What length and weight of number 60's twist, will it require for a piece of cloth $29\frac{1}{5}$ yards long, 39 inches wide, and 106 ends in an inch?

29.2 yards, length of piece.
39 inches, width at reed.

2628
876

1138.8
106 ends to an inch.

68328
113880

Dividend, 120712.8 yards of twist required for a piece.

840 yards, 1 hank.
60's twist.

Divisor, 50400 yards in 1 lb. of number 60's twist.

50400)120712.8(2 lbs., 6¼ oz., weight of twist re-
100800 quired for 1 piece of cloth.

19912.8
16 ounces, 1 lb.

1194768
199128

50400)318604.8(6 ounces.
302400

16204.8
4 qrs., 1 oz.

50400)64819.2(1 qr.
50400

14419

The weight of number 60's twist required for 1 piece of cloth, is 2 lbs., 6¼ oz., or 11 lbs., 15¼ ounces, for 1 warp containing 5 pieces.

What weight of number 80's weft, will it require to weave 1 piece of cloth 29⅕ yards long, 120 picks, or threads in an inch, and 39 inches wide, allowing 1-50th for waste?

840 yards 1 hank.
80's weft.

67200 divisor.

29.2 yards, length of piece.
120 picks, or threads in an inch.

3504.0
39 inches, width at reed.

315360
105120

136656.0
Add 1-50th for waste 273312

Yds. in 1 lb., 67200)139389.12(2 lbs., 1-5th oz., weight of weft
134400 required to weave a piece of cloth.

4989.12
16

2993472
498912

67200)79825.92(1 ounce.
67200

12625 = 1-5th.

What number of ends will it require in a warp, to fill 50 inches in a 96 reed, Manchester count?

96, count of reed.
50 inches, width at reed.

4800, number of ends required in warp.

What number of ends will it require in a warp, to fill 40½ inches in a 118 Manchester count?

118, count of Manchester reed.
40.5 inches, width at reed.

590
4720

4779.0 number of ends in warp.

What number of ends will it require to fill 50 inches in a 60 reed, Bolton count, 20 dents, or 40 ends to the beer?

60 reed, Bolton count.
40 ends, or 20 dents in 1 beer.

2400
50 inches, width at reed.

120000

24¼ inches, or 24.25)120000.00(4948 ends required in the warp.
9700

23000
21825

11750
9700

20500
19400

1100

N. B.—It is not requisite to carry out the decimal fractions of an end.

For the different systems of counting reeds, see the reed table, with rules and examples.

What number of ends will be required in a warp, to fill 51 inches, in a 66 reed, Bolton count?

66 count of reed.
40 ends, or 20 dents to a beer.

2640
51 inches, width at reed.

2640
13200

134640 dividend.

24¼, or 24.25 inches.)134640(5552 ends required for warp.
12125

13390
12125

12650
12125

5250
4850

400

What number of ends will it require in a warp, to fill 30½ inches in a 74 reed, Blackburn count?

74 count of reed.
40 ends, or 20 dents to a beer.

2960
30.5 inches, width of warp at the reed.

14800
88800

Beers set on 45 inches.)90280.0(2006 ends required for warp.
90

280
270

10

What width will 2006 ends fill, in a 74 reed, Blackburn count?
74, count of reed.
40 ends, or 20 dents to a beer.

2960 divisor.
Number of ends in warp, 2006
45 inches, number of beers set on.

10030
8024

90270 dividend.

90270 dividend by 2960=30.5, or 30½ in. nearly, width of warp at reed.

What number of ends will it require in a warp, to fill 49½ inches, in a 135 reed, Blackburn count?

135, count of reed.
40 ends, or 20 dents to a beer.

5400
49.5 inches, width of warp at the reed.

27000
48600
21600

45 inches, or { 9)267300.0
5)29700

5940 ends required in the warp.

What number of inches will 5940 ends fill, in a 135 reed, Blackburn count?

135, count of reed.
40 ends, or 20 dents to a beer.

5400 divisor.

5940 ends in the warp.
45 inches, number of beers set on reed.

29700
23760

5400)267300(49.5, or 49½ inches, width of warp at the reed.
21600

51300
48600

27000
27000

What number of ends must there be in a warp, to fill 48 inches in a Bolton 54 reed; allowing only 19 dents, or 38 ends to a beer?

54, count of reed.
38 ends, or 19 dents to a beer.

432
162

2052
48 inches, width of warp at the reed.

16416
8208

No. of brs. set on inches. } 24.25)98496.00(4062 ends required in the warp.
9700

14960
14550

4100
4850—nearly.

What number of inches will 4062 ends fill in a Bolton 54 reed; allowing 19 dents, or 38 ends to a beer?

54, count of reed.
38 ends, or 19 dents to a beer.

432
162

2052 divisor.

4062 ends in the warp.
24.25 inches, numbers of beer set on.

20310
8124
16248
8124

2052)98503.50(48 inches, width filled at the reed.
8208

16423
16416

7

What number of ends must there be in a warp, to fill 39½ inches in a Bolton 44 reed; if there be 19 dents, or 38 ends to a beer?

44, count of reed.
38 ends, or 19 dents to a beer.
352
132
1672
39.5, or 39½ inches, width of warp at the reed.
8360
15048
5016
No. of beers set on 24.25 in.)66044.00(2723 ends required for the warp.
4850
17544
16975
5690
4850
8400
7275
125

What number of inches will 2724 ends fill in a 44 reed, Bolton count; allowing 19 dents, or 38 ends to a beer?

44, count of reed.
38 ends, or 19 dents to a beer.
352
132
1672 divisor.

2724 number of ends in the warp.
24.25, or 24½ inches, number of beers set on.
13620
5448
10896
5448
1672)66057.00(39.5, or 39½ inches, width filled at the reed.
5016
15897
15048
8490
8360
130

What number of ends must there be in a warp, to fill 51½ inches, in a 6-4ths 110 reed, Preston count?

110, count of reed, 6-4ths Preston.
40 ends, or 20 dents in a beer.
4400
51.5, or 51½ inches, width of warp at the reed.
22000
4400
22000
No. of beers set on 58 in.)226600.0(3907, No. of ends required for the warp.
174
526
522
400
406—nearly.

What number of inches will 3907 ends fill, in a 6-4ths 110 reed, Preston count?

110 count of reed, 6-4ths Preston.
40 ends, or 20 dents to a beer.

4400 divisor.

3907, number of ends in the warp.
Number of beers set on 58 inches.

31256
19535

4400)226606(51.5, or 51½ inches, width filled at the reed.
22000

6606
4400

22060
22000

60

N. B.—The 6-4*ths Preston count of reeds, is the number of beers set on* 58 *inches,* 20 *dents, or* 40 *ends to a beer.*

The small difference which appears in the last two examples arises from the decimal of an end.

What number of ends must there be in a warp, to fill 51½ inches, in a 6-4ths 144 reed, Preston count?

144, number of beers set on 58 inches at the reed.
40 ends, or 20 dents to a beer.

5760
51.5, or 51½ inches, width of warp at the reed.

28800
5760
28800

296640.0

```
58 inches.)296640.0(5114, number of ends required for the warp.
           290
           ———
            66
            58
            ———
             84
             58
             ———
             260
             232
             ———
              28
```

What number of inches will 5114 ends fill, in a 6-4ths 144 reed, Preston count?

```
                                 144, count of reed.
                                   40 ends, or 20 dents to a beer.
                                 ————
                                 5760 divisor.

                              5114, number of ends in the warp.
Number of beers set on          58 inches.
                            ——————
                             40912
                            25570
                            ——————
                       5760)296612(51.5, or 51½ inches, filled at the
                            28800                              reed.
                            ——————
                              8612
                              5760
                              ——————
                              28520
                              28800—nearly.
```

N. B.—The divisor is ascertained by multiplying the number of beers set on any given number of inches (according to the adopted rule), by the number of ends in a beer at the reed; and the dividend by multiplying the number of ends in the warp, by the number of inches any given number of beers is set on at the reed.

What number of ends must there be in a warp to fill 40½ inches, in a 9-8ths 125 reed, Preston count?

125, count of reed.
40 ends, or 20 dents to a beer.
5000
40.5, or 40½ inches, width of warp at the reed.
25000
200000
No. of beers set on inches, 44)202500.0(4602, number of ends required for the warp.
76
265
264
100
88
12

What number of inches will a warp containing 4602 ends fill, in a 9-8ths 125 reed, Preston count?

125 count of reed.
40 ends, or 20 dents in a beer.
5000 divisor.

4602 number of ends in the warp.
Number of beers set on 44 inches.
18408
18408
5.000)202.488
40.4976, or nearly 40½ inches, width the warp fills at reed.

N. B.—The 9-8*ths Preston count of reeds is calculated according to the number of beers set on* 44 *inches,* 20 *dents to a beer.*

When calculating the width at the reed any warp will fill according to the number of ends, the count of the reed must be multiplied by the number of ends filling 1 beer at the reed, for a divisor, whether 2, 3, 4, or more ends be in a dent, which will be according to the kind of goods made.

What number of ends must there be in a warp, to fill 39½ inches, in a 9-8ths 105 reed, Preston count?

```
                                105, count of reed.
                                  40 ends, or 20 dents to a beer.
                                ----
                                4200
                                  39.5, or 39½ inches, width of warp
                                -----                     at the reed.
                                21000
                               37800
                              12600
                              -------
No. of beers set on 44 in.)165900.0(3770 number of ends required
                           132                          for the warp.
                           ---
                            339
                            308
                            ---
                             310
                             308
                             ---
                              20
```

What number of inches will a warp containing 3770 ends fill, in a 9-8ths 105 reed, Preston count?

```
                                105, count of reed.
                                  40 ends, or 20 dents to a beer.
                                ----
                                4200 divisor.

                          3770 number of ends in the warp.
  No. of beers set on       44 inches.
                         ------
                          15080
                         15080
                         ------
                         165880
```

4200)165880(39.49, or 39½ inches, width filled at the reed.
12600
39880
37800
20800
16800
40000
37800
2200

N. B.—Some manufacturers in Preston count their 9-8*ths,* 4-4*ths, and* 7-8*ths reeds, in the same proportion to a* 6-4*ths, set on* 58 *inches.*

What number of ends must there be in a warp, to fill 37 inches in a 4-4th, or yard wide 115 reed, Preston count?

115, count of reed.
40 ends, or 20 dents to a beer.
4600
37 inches, width of warp at the reed.
32200
13800
170200

No. of beers set on 39 in.)170200(4364 number of ends required for the warp.
156
142
117
250
234
160
156
4

How many inches will a warp containing 4364 ends fill, in a 4-4ths, or yard wide 115 reed, Preston count?

115, count of reed.
40 ends, or 20 dents to a beer.

4600 divisor.

4364 number of ends in the warp.
Number of beers set on 39 inches.

39276
13092

4600)170196(36.999, or 37 inches, width the warp fills at reed.
13800

32196
27600

45960
41400

45600
41400

42000
41400

600

N. B.—The 4-4*ths, or yard wide Preston count of reed, is calculated according to the number of beers set on* 39 *inches,* 20 *dents to a beer.*

What number of ends must there be in a warp, to fill 34½ inches, in a 4-4ths, or yard wide reed, Preston count?

96, count of reed.
40 ends, or 20 dents to a beer.

3840
34.5, or 34½ inches width of warp at the reed.

19200
15360
11520

132480.0

No. of beers set on 39 in.)132480.0(3397, number of ends required for the warp.
117
―――
154
117
―――
378
351
―――
270
273—nearly.

How many inches will a warp containing 3397 ends fill, in a 4-4ths or yard wide 96 reed, Preston count?

96, count of the reed.
40 ends, or 20 dents to a beer.
―――
3840 divisor.

3397 number of ends in the warp.
No. of beers set on 39 inches.
―――
30573
10191
―――
3840)132483(34.5, or 34½ inches, warp fills at the reed.
11520
―――
17283
15360
―――
19230
19200
―――
30

N. B.—The 9-8*ths set on* 43½ *inches; the* 4-4*ths, or yard wide, set on* 38⅔ *inches, and the* 7-8*ths set on* 33⅚ *inches, will be in proportion to the* 6-4*ths reed being set on* 58 *inches.*

What number of ends must there be in a warp, to fill 32½ inches, in a 7-8ths 66 reed, Preston count?

66, count of reed.
40 ends, or 20 dents to a beer.

2640
32.5, or 32½ inches, width of warp at the reed.

13200
5280
7920

No. of brs. set on 34 in.)85800.0(2523 number of ends required for the warp.
68

178
170

80
68

120
102

18

How many inches will a warp containing 2523 ends fill, in a 7-8ths 66 reed, Preston count?

66, count of reed.
40 ends, or 20 dents to a beer.

2640 divisor.

2523 number of ends in the warp.
Number of beers set on 34 inches.

10092
7569

85782

2640)85782(32.49, or 32½ inches, warp fills at the reed.
7920
6582
5280
13020
10560
24600
23760
840

N. B.—The 7-8ths Preston count of reeds is calculated by the number of beers set on 34 *inches,* 20 *dents to a beer.*

What number of ends must there be in a nankeen warp, to fill 31½ inches, in a 60 reed?

60, count of reed.
38 ends, or 19 dents to a beer.
480
180
2280
31.5, or 31½ inches, width of warp at the reed.
11400
2280
6840
No. of brs. set on, 2.0 in.)7182.0.0
3591 No. of ends required for the warp.

What number of ends must there be in a nankeen warp, to fill 21 inches, in a 48 reed?

48, count of reed.
38 ends, or 19 dents to a beer.

384
144

1824
21 inches, width of warp at the reed

1824
3648

No. of beers set on 2.0 in.)3830.4

1915 No. of ends required for the warp.

What number of inches will a nankeen warp containing 1915 ends fill, in a 48 reed?

48, count of reed.
38 ends in a beer.

384
144

1824 divisor.

1915, number of ends in the warp.
20 inches, number of beers set on.

1824)38300(21 inches, width warp fills at the reed.
3648

1820
1824—nearly.

N. B.—The nankeen count of reeds is calculated by the number of beers set on 20 *inches,* 19 *dents to a beer.*

How many ends must there be in a warp, to fill 51½ inches, in a 1850 reed, Scotch count?

1850, count of reed.

51.5, or 51½ inches, width of warp at the reed.

9250

1850

9250

95275.0

2 ends in a dent, or split.

No of dents set on 37 in.)190550(5150 number of ends required for the warp.

185

55

37

185

185

0

Now many inches will a warp containing 5150 ends fill, in a 1850 reed, Scotch count?

1850, count of reed.

2, number of ends in a dent, or split.

3700 divisor.

5150, number of ends in the warp.

Number of dents set on 37 inches.

36050

15450

3700)190550(51.5, or 51½ inches, warp fills at the reed.

18500

5550

3700

18500

18500

N. B.—In Carlisle, Scotland, Ireland, and the United States of America, they calculate their reeds by the number of dents set on 37 *inches.*

In Carlisle and Scotland a dent is generally termed a split.

How many ends must there be in a warp, to fill 49½ inches, in a 2150 reed, Scotch count?

2150, count of reed.
2, number of ends in a dent, or split.
———
4300
49.5, or 49½ inches, width of warp at the reed.
———
21500
38700
17200
———
No. of dents set on 37 in.)212850.0(5752, number of ends required for the warp.
185
———
278
259
———
195
185
———
100
74
———
26

How many inches will a warp containing 5752 ends fill, in a 2150 reed, Scotch count?

2150, count of reed.
2, number of ends in a dent, or split.
———
4300 divisor.

5752, number of ends in the warp.
Number of dents set on 37 inches.
———
40264
17256
———
212824

4300)212824(49.49, or 49½ inches, nearly,
17200 warp fills at the reed.

40824
38700

21240
17200

40400
38700

1700

What number of ends must there be in a silk warp, to fill 19 inches, in a 3700 reed?

3700, count of reed.
19 inches, width of warp required at the reed.

33300
3700

No. of ends in 36 in.)70300(1952 number of ends required
36 for the warp.

343
324

190
180

100
72

28

How many inches will a silk warp containing 1952 ends fill, in a 3700 reed?

1952 number of ends in the warp.
Number of ends in 36 inches.

11712
5856

70272

Count of reed 3700)70272(18.99, or 19 inches, nearly, width
3700 the warp fills at the reed.
33272
29600
36720
33300
34200
33300
900

N. B.—The silk manufacturers generally calculate their reeds by twice the number of dents, or the number of ends in 36 *inches at the reed.*

LINEN YARN TABLES.

SHOWING the weight of 1 lea, or cut, English hank and bundle, Irish and Scotch hank, spangle, or spindle, and bundle, from 1 to 300 leas or cuts in the pound progressively.

The following are the different sizes of reels in use, with the different systems of making up yarns.

YORKSHIRE REEL.

3 yards, or 108 inches in circumference.
100 threads, 1 lea, 300 yards.
10 leas, 1 hank, 3.000 yards.
20 hanks, 1 bundle, 60.000 yards.
Sells per bundle.

DORSET REEL.

2¼ yards, or 81 inches in circumference.
40 threads, 1 knot, 90 yards.
20 knots, 1 ran, 1.800 yards.
12 rans, 1 dozen, 21.600 yards.
Sells per dozen.

N. B.—This reel is not much in use, the Irish reel being gen rally adopted.

IRISH AND SCOTCH REELS.

2½ yards, or 90 inches in circumference.
120 threads, 1 cut, 300 yards.
12 cuts, 1 hank, 3.600 yards.
4 hanks, 1 spangle, 14.400 yards.
12½ spangles, or 50 hanks, 1 bundle, 180.000 yds.
Sells per spangle in bundles.

POINTS IN WHICH THE THREE REELS AGREE.

40 knots, or 2 rans, make 1 hank Irish and Scotch, 3.600 yards.
8 hanks Dorset, or 4 hanks Irish and Scotch, make 1 spangle or spindle, 14.400 yards.
1½ spangles or spindles, make 1 dozen Dorset, 21.600 yards.
12½ spangles or spindles, or 50 hanks Irish and Scotch, or 3 English bundles of 60.000 yards each, make 1 Irish bundle, 180.000 yards.

EXPLANATION TO THE LINEN YARN TABLES.

The first column is the numbers of yarn, opposite to which is the weight according to the length weighed.

N. B.—The pounds and ounces are avoirdupois weight, and the pennyweights and grains are troy weight.

oz.	dwts.	grains.	grains.	
14	11	16	or 7000	troy are equal to 1 lb. avoirdupois.
	18	5½	or 437½	troy are equal to 1 oz. avoirdupois.

The following are the dividends according to the length weighed.

	Yards.	Dividends.
1 lea, or cut	300	7.000
1 English hank	3.000	70.000
1 Irish and Scotch hank	3.600	84.000
1 spangle or spindle	14.400	336.000
1 English bundle	60.000	1.400.000
1 Irish bundle	180.000	4.200.000
1 knot, Dorset	90	2.100
1 ran, do.	1.800	42.000
1 dozen, do.	21.600	504.000

N. B.—By dividing any of the above dividends, according to the length weighed, by the number of grains in the weight, it will give the numbers of yarns; or divide by the numbers of yarns, and it will give the number of grains weight, according to the length weighed.

LINEN YARN TABLE.

From Number 1 to 110 leas or cuts in the pound.

Weight per lea or cut of 300 yards.				Weight per English hank of 3000 yards.				Weight per English bundle of 60,000 yards.			
Nos.	oz.	dwts.	grains.	lbs.	oz.	dwts.	grains.	lbs.	oz.	dwts.	grains.
1	16	0	0.	10	0	0	0.	200	0	0	0.
2	8	0	0.	5	0	0	0.	100	0	0	0.
3	5	6	1.83	3	5	6	1.83	66	10	12	3.66
4	4	0	0.	2	8	0	0.	50	0	0	0.
5	3	3	15.5	2	0	0	0.	40	0	0	0.
6	2	12	3.66	1	10	12	3.66	33	5	6	1.83
7	2	5	5.	1	6	15	15.	28	9	2	14.5
8	2	0	0.	1	4	0	0.	25	0	0	0.
9	1	14	4.27	1	1	14	4.27	22	3	10	3.05
10	1	10	22.5	1	0	0	0.	20	0	0	0.
11	1	8	6.83		14	9	22.63	18	2	16	13.72
12	1	6	1.83		13	6	1.83	16	10	12	3.66
13	1	4	4.96		12	5	14.61	15	6	2	19.3
14	1	2	14.5		11	7	19.5	14	4	10	10.
15	1	1	5.16		10	12	3.6	13	5	6	1.83
16	1	0	0.		10	0	0.	12	8	0	0.
17		17	3.76		9	7	12.14	11	12	4	6.94
18		16	4.88		8	16	4.88	11	1	14	4.27
19		15	8.41		8	7	16.21	10	8	7	16.21
20		14	14.		8	0	0.	10	0	0	0.
25		11	16.		6	7	7.	8	0	0	0.
30		9	17.33		5	6	1.83	6	10	12	3.66
35		8	8.		4	10	10.	5	11	7	19.5
40		7	7.		4	0	0.	5	0	0	0.
45		6	11.55		3	10	3.05	4	7	2	0.61
50		5	20.		3	3	15.5	4	0	0	0.
55		5	7.25		2	16	13.72	3	10	3	7.54
60		4	20.66		2	12	3.66	3	5	6	1.83
65		4	11.69		2	8	9.92	3	1	4	4.96
70		4	4.		2	5	5.	2	13	13	0.5
75		3	21.33		2	2	10.33	2	10	12	3.66
80		3	15.5		2	0	0.	2	8	0	0.
85		3	10.35		1	16	2.02	2	5	11	19.08
90		3	5.77		1	14	4.27	2	3	10	3.05
95		3	1.68		1	12	11.3	2	1	12	11.34
100		2	22.		1	10	22.5	2	0	0	0.
105		2	18.66		1	9	13.1	1	14	8	6.33
110		2	15.63		1	8	6.8	1	13	1	15.77

Required, the weight of 1 lea of number 18's yarn?

Dividend.
Numbers of yarn, 18)7000(388.8 grains, or 16 dwts., $4\frac{8}{9}$ grains, weight required.
54
160
144
160
144

160
144
16

Required, the weight of 1 English hank of number 18's yarn?

Dividend.
Numbers of yarn, 18)70000(3888.88 grains, or 8 oz., 16 dwts., $4\frac{8}{9}$ grains, weight required.
54
160
144
160
144
160
144

160
144
160
144
16

How many ounces, pennyweights, and grains, are there in 3888.88 grains?

Grains. Grains.
1 oz. is equal to 437.5)3888.88(8 ounces.
35000

1 pennyweight is 24 grs.)388.88(16 dwts.
24
148
144
4.88 grains.

8 oz., 16 dwts., 4.88 grains, weight required.

LINEN YARN TABLE.

From Number 1 to 110 leas or cuts in 1 pound.

	Weight per Irish and Scotch hank of 3600 yards.				Weight per spangle or spindle of 14,400 yards.				Weight per Irish bundle of 180,000 yards.			
Nos.	lbs.	oz.	dwts.	grains.	lbs.	oz.	dwts.	grains.	lbs.	oz.	dwts.	grains.
1	12	0	0	0.	48	0	0	0.	600	0	0	0.
2	6	0	0	0.	24	0	0	0.	300	0	0	0.
3	4	0	0	0.	16	0	0	0.	200	0	0	0.
4	3	0	0	0.	12	0	0	0.	150	0	0	0.
5	2	6	7	7.	9	9	10	22.5	120	0	0	0.
6	2	0	0	0.	8	8	0	0.	100	0	0	0.
7	1	11	7	19.5	6	13	13	0.5	85	11	7	19.5
8	1	8	0	0.	6	0	0	0.	75	0	0	0.
9	1	5	6	1.83	5	5	6	1.83	66	10	12	3.6
10	1	3	3	15.5	4	12	14	14.	60	0	0	0.
11	1	1	8	6.86	4	5	14	21.95	54	8	13	6.1
12	1	0	0	0.	4	0	0	0.	50	0	0	0.
13		14	14	0.53	3	11	1	9.65	46	2	8	9.9
14		13	13	0. 5	3	6	15	15.	42	13	13	0.5
15		12	14	14.	3	3	3	15.5	40	0	0	0.
16		12	0	0.	3	0	0	0.	37	8	0	0.
17		11	5	8.67	2	13	3	5.2	35	4	12	20.8
18		10	12	3.66	2	10	12	3.66	33	5	6	1.8
19		10	1	22.05	2	8	7	16.21	31	9	4	19.1
20		9	10	22.5	2	6	7	7.	30	0	0	0.
25		7	12	9.5	1	14	13	3.	24	0	0	0·
30		6	7	7.	1	9	10	22.5	20	0	0	0.
35		5	8	20.5	1	5	17	4.5	17	2	5	5.
40		4	14	14.	1	3	3	15.5	15	0	0	0.
45		4	4	20.66	1	1	1	5.16	13	5	6	1.8
50		3	15	7.5		15	6	13.5	12	0	0	0.
55		3	8	22.77		13	17	13.59	10	14	9	22.6
60		3	3	15.5		12	14	14.	10	0	0	0.
65		2	17	9.3		11	14	20.73	9	3	12	14.8
70		2	13	13.		10	17	17.	8	9	2	14.5
75		2	10	5.		10	4	9.	8	0	0	0.
80		2	7	7.		9	10	22.5	7	8	0	0.
85		2	4	17.23		9	0	15.44	7	0	17	3.7
90		2	2	10.33		8	9	17.33	6	10	12	3.6
95		2	0	9.21		8	1	12.84	6	5	0	23.0
100		1	16	18.5		7	12	9.5	6	0	0	0.
105		1	15	2.5		7	5	17.5	5	11	7	19.5
110		1	13	14.13		6	17	21.54		7	4	23.3

Required, the weight of 1 spangle of number 19's yarn?

Dividend.
Numbers of yarn, 19)33600(17684.2 grains, weight required.
19
———
146
133
———
130
114
———
160
152
———
80
76
———
40
38
—
2

How many pounds, ounces, and pennyweights are there in 17684.2 grains?

Grains. Grains.
1 lb. is equal to 7000)17684.2(2 lbs., 8 oz., 7 dwts., $16\frac{1}{5}$ grains.
14000
———
1 oz. is equal to 437.5 grs.)3684.2(8 oz.
35000
———
1 dwt. is equal to 24 grs.)184.2(7 dwts.
168
———
$16\frac{1}{5}$ grains.

Required, the weight of 1 English bundle of number 34's yarn?

Dividend.
Numbers of yarn, 34)1400000(41176 grains, or 5 lbs., 14 oz., 2 dwts., $3\frac{1}{2}$ grains.
136
———
40
34
———
60
34
———
260
238
———
220
204
———
16

LINEN YARN TABLE.

From Number 115 to 300 leas in 1 pound.

Weight per lea, or cut of 300 yards.			Weight per English hank of 3000 yards.			Weight per English bundle of 60,000 yards.			
Nos.	dwts.	grains.	oz.	dwts.	grains.	lbs.	oz.	dwts.	grains.
115	2	12.86	1	7	3.1	1	11	15	1.41
120	2	10.33	1	6	1.8	1	10	12	3.66
125	2	8.	1	5	2.5	1	9	10	22.5
130	2	5.84	1	4	4.96	1	8	11	5.23
135	2	3.85	1	3	9.03	1	7	12	19.87
140	2	2.	1	2	14.5	1	6	15	14.
145	2	0.27	1	1	21.25	1	6	1	6.17
150	1	22.66	1	1	5.18	1	5	6	1.83
155	1	21.16	1	0	14.11	1	4	11	18.25
160	1	19.75	1	0	0.	1	4	0	0.
165	1	18.42		17	16.24	1	3	7	4.34
170	1	17.17		17	3.74	1	2	15	0.29
175	1	16.		16	16.	1	2	5	5.
180	1	14.88		16	4.88	1	1	14	4.27
185	1	13.83		15	18.37	1	1	5	10.06
190	1	12.84		15	8.42	1	0	15	8.42
195	1	11.89		14	22.97	1	0	7	11.48
200	1	11.		14	14.	1	0	0	0.
205	1	10.14		14	5.46		15	11	2.76
210	1	9.33		13	21.33		15	4	8.16
215	1	8.55		13	13.58		14	16	2.62
220	1	7.81		13	6.18		14	9	22.63
225	1	7.11		12	23.11		14	4	1.22
230	1	6.43		12	16.34		13	16	15.45
235	1	5.78		12	9.87		13	11	5.95
240	1	5.16		12	3.66		13	6	1.83
245	1	4.571		11	21.71		13	1	2.785
250	1	4.		11	16.		12	14	14.
255	1	3.45		11	10.5		12	10	0.196
260	1	2.923		11	5.23		12	5	14.615
265	1	2.414		11	0.14		12	1	9.018
270	1	1.925		10	19.25		11	15	12.685
275	1	1.454		10	14.54		11	11	14.
280	1	1.		10	10.		11	7	19.
285	1	0.561		10	5.67		11	4	3.
290	1	0.137		10	1.37		11	0	15.
295		23.728		9	21.28		10	15	10.
300		23.333		9	17.33		10	12	3.

Required, the weight of 1 Irish bundle of 66's yarn.

Numbers of yarn, 66)4200000(63636.36 grains.
396
240
198
420
396
240
198
420
396
240
198
420
396
24

Grains. Grains.
1 lb. is equal to 7000)63636.36(9 lbs., 1 oz., 8 dwts., 6.86 grs.
63000 weight required.

1 oz. is equal to 437.5 grs.)636.36(1 oz.
4375

8 dwt. is equal to 24 grns.)198.86(8 dwts.
192

6.86 grains.

Or,

```
                           lbs.
Numbers of yarn, 66)600(9 lbs., 1 oz., 8 dwts., 6.86 grains,
                    594                     weight required.
                    ---
                      6
                     16 oz., 1 lb.
                    ---
 Numbers of yarn, 66)96(1 oz.
                     66
                     --
                     30
                  437.5 grains, 1 oz.
                 ------
Nos. of yarn, 66)13125.0(198.86 grains or 8 dwts., 6.86 grs.
                 66
                 ---
                 652
                 594
                 ---
                  585
                  528
                  ---
                   570
                   528
                   ---
                    42
```

LINEN YARN TABLE.

From Number 115 to 300 leas, or cuts in 1 pound.

Weight per Irish and Scotch hank of 3600 yards.				Weight per spangle or spindle of 14,400 yds.			Weight per Irish bundle of 180,000 yards.			
Nos.	oz.	dwts.	grains.	oz.	dwts.	grains.	lbs.	oz.	dwts.	grains.
115	1	12	4.93	6	12	8.74	5	3	8	17.23
120	1	10	22.5	6	7	7.	5	0	0	0.
125	1	9	18.5	6	2	15.	4	12	14	14.
130	1	8	16.65	5	16	13.11	4	9	15	10.19
135	1	7	16.72	5	12	13.38	4	7	2	0.61
140	1	6	18.5	5	8	20.5	4	4	10	10.
145	1	5	21.81	5	5	9.74	4	2	3	18.51
150	1	5	2.5	5	2	4.5	4	0	0	0.
155	1	4	8.43	4	17	9.74	3	13	17	1.37
160	1	3	15.5	4	14	14.	3	12	0	0.
165	1	2	23.59	4	11	22.36	3	10	3	7.54
170	1	2	8.61	4	9	10.47	3	8	8	13.87
175	1	1	18.5	4	7	2.	3	6	15	15.
180	1	1	5.16	4	4	20.66	3	5	6	1.83
185		0	16.55	4	2	18.21	3	3	16	6.2
190		0	4.6	4	0	18.42	3	2	9	14.26
195		17	22.76	3	17	2.57	3	1	4	4.96
200		17	12.	3	15	7.5	3	0	0	0.
205		17	1.756	3	13	14.52	2	14	15	2.8
210		16	16.	3	11	23.5	2	13	13	0.5
215		16	6.69	3	10	10.29	2	12	11	20.88
220		15	21.81	3	8	22.77	2	11	11	14.41
225		15	13.33	3	7	12.84	2	10	12	3.66
230		15	5.21	3	6	4.37	2	9	13	11.36
235		14	21.44	3	4	21.28	2	8	15	12.34
240		14	14.	3	3	15.5	2	8	0	0.
245		14	6.857	3	2	10.928	2	7	3	8.357
250		14	0.	3	1	7.5	2	6	7	7.
255		13	17.411	3	0	5.147	2	5	11	19.088
260		13	11.076	2	17	9.307	2	4	16	19.846
265		13	4.981	2	16	8.924	2	4	4	3.054
270		12	23.111	2	15	9.444	2	3	10	3.055
275		12	17.45	2	14	10.81	2	2	16	17.72
280		12	12.	2	13	13.	2	2	5	5.
285		12	6.73	2	12	15.94	2	1	12	11.34
290		12	1.65	2	11	19.62	2	1	1	21.25
295		11	20.74	2	10	23.98	2	0	9	21.28
300		11	16.	2	10	5.	2	0	0	0.

Required, the weight of an Irish or Scotch hank of number 68's yarn:—

```
                        Dividend.
Numbers of yarn, 68)84000(1235.29 grains.
                     68
                     ——
                     160
                     136
                     ———
                      240
                      204
                      ———
                       360
                       340
                       ———
                        200
                        136
                        ———
                         640
                         612
                         ———
                          28
```

```
                  Grains. Grains.
1 oz. is equal to 437.5)1235.29(2 oz., 15 dwts., 0.29 grains, wt.
                        8750                             required.
                        ————
1 dwt. is equal to 24 grns.)360.29(15 dwts.
                            24
                            ——
                            120
                            120
                            ———
                              0.29 grain.
```

How many yards are there in 1 lb. and in 1 oz. of number 68's yarn?

```
                     300 yards is 1 lea, or cut.
Numbers of yarn,      68
                   —————
                   20400 number of yards in 1 lb.
```

1 lb. is equal to 16 oz.)20400(1275 yards in 1 oz.
16
44
32
120
112
80
80

Required, the weight of 1 spangle of number 85's yarn:—

Dividend.
Numbers of yarn, 85)336000(3952.94 grains.
255
810
765
450
425
250
170
800
765
355
340
15

Grains. Grains.
1 oz. is equal to 437.5)3952.94(9 oz., 0 dwts., 15.44 grs., weight required.
39375
15.44

If 1 spangle of linen yarn weighs 9 oz., 15½ grains; what numbers will it be?

9 oz., 15.5 grains.
437.5 grains are equal to 1 oz.

3953.0 grains.

Grains. Dividend.
9 oz., 15½ grns. are equal to 3953)336000(85 leas, or cuts in 1 lb.
31624 which is the nos. of yarn.

19760
19765—nearly.

How many yards of number 85's yarn are there in 1 lb. and in 1 oz.?

300 yards, 1 lea, or cut.
85, numbers of yarn.

16 oz., 1 lb. { 4)25500 yards in 1 lb.
4)6375

1593.75, or 1593¾ yards in 1 oz.

Required, the weight of an Irish, or Scotch hank of number 95's yarn:—

Dividend.
Numbers of yarn, 95)84000(884.21 grains, weight required.
760

800
760

400
380

200
190

100
95

5

Grains. Grains.
1 oz. is equal to 437.5)884.21(2 oz., 0 dwts., 9.91 grains, weight
8750 required.
9.21 grains.

If 1 Irish or Scotch hank of linen yarn weighs 2 oz., 0 dwts., 9¼ grains, what numbers will it be?

437.5 grains are equal to 1 oz.
2
875.0 grains are equal to 2 oz.
Add 9.25 grains.
884.25 grs. is equal to 2 oz., 0 dwts., 9¼ grs.

Grains. Dividend.
884.25)84000.00(9499, or nearly 95 numbers of yarn.
795825
441750
353700
880500
795825
846750
795825
50925

Required, the weight of 1 Irish bundle of number 107's yarn :—

Dividend.
Numbers of yarn, 107)4200000(39252.33 grains, weight required.
321
990
963
270
214
560
535
250
214
360
321
390
321
69

Grains. Grains.
1 lb. is equal to 7000)39252.33(5 lbs., 9 oz., 13 dwts., 283
35000 grains, weight required.

1 oz. is equal to 437.5 grns.)4252.33(9 oz.
39375

1 dwt. is equal to 24 grains)314.83(13 dwts.
24
74
72
2.83 grains.

If 1 Irish bundle of linen yarn weighs 5 lbs., 9 oz., 13 dwts., 2.83 grains, or 39252.33 grains, what number will it be?

Grains.
39252.33)4200000.00(107, numbers of yarn.
3925233

27476700
27476631

69

Required, the weight of 1 English bundle of number 138's yarn:—

Dividend.
Numbers of yarn, 138)1400000(10144.927 grs., weight required.
138

200
138

620
552

680
552

1280
1242

380
276

1040
966

74

Grains. Grains.
1 lb. is equal to 7000)10144.927(1 lb., 7 oz., 3 dwts., 10.427 grains, weight required.
7000

1 oz. is equal to 437.5 grs.)3144.927(7 oz.
30625

1 dwt. is equal to 24 grains)82.427(3 dwts.
72

10.427 grains.

If 1 English bundle of linen yarn weighs 1 lb., 7 oz., 3 dwts., 10½ grains, what numbers will it be?

Grains. Dividend.
1 lb., 7 oz., 3 dwts., 10½ grs., =10145)1400000(138, numbers of
10145 yarn nearly.
38550
30435
81150
81160—nearly.

Required, the weight of 1 English hank of number 138's yarn:—

Dividend.
Numbers of yarn, 138)70000(507.246 grains, weight required.
690
1000
966
340
276
640
552
880
828
52

Grains. Grains.
1 oz. is equal to 437.5)507.246(1 oz., 2 dwts., 21¾ grns. nearly, weight required.
4375

1 dwt. is equal to 24 grs.)69.746(2 dwts.
48
21.746 grains.

Required, the weight of 1 English bundle of number 128's yarn:—

Dividend.
Numbers of yarn, 128)1400000(10937.5 grains, weight required.
128

1200
1152

480
384

960
826

640
640

Grains. Grains.
1 lb. is equal to 7000)10937.5(1 lb., 9 oz., weight required.
7000

1 oz. is equal to 437.5 grs.)3937.5(9 oz.
39375

Required, the weight of 1 lea, or cut of 154's yarn:—

Dividend.
Numbers of yarn, 154)7000(45.45 grains, or nearly 1 dwt., 21½ grains, weight required.
616

840
770

700
616

840
770

70

Required, the weight of 1 English hank of number 154's yarn:—

```
Numbers of yarn, 154)700000(454.54 grains, weight required.
                     616
                     ---
                      840
                      770
                      ---
                       700
                       616
                       ---
                        840
                        770
                        ---
                         700
                         616
                         ---
                          84
```

How many ounces, pennyweights, and grains, are there in 454.54 grains?

```
1 oz. is equal to 437.5 grns.)454.545454(1.03896 ounces.
                              4375          437.5 grains =1 oz.
                              -----         -----
                               17045         19480
                               13125        27272
                               -----       11688
                                39204     15584
                                35000     ---------
                                -----     17.045000 grs., or 1 oz.
                                 42045           0 dwts., 17 grns.,
                                 39375             weight required.
                                 -----
                                  26704
                                  26250
                                  -----
                                    454
```

Required, the weight of 1 English bundle of number 165's yarn :—

Dividend.
Numbers of yarn, 165)1400000(8484.848 grains, weight required.
1320
800
660
1400
1320
800
660
1400
1320
800
660
1400
1320
80

How many pounds, ounces, pennyweights, and grains are there in 8484.848 grains ?

Grains. Grains.
1 lb. =7000)8484.848(1 lb., 3 oz., 7 dwts., 4.348 grains.
7000
1 oz. =437.5 grns.)1484.848(3 oz.
13125
1 dwt. =24 grains,)172.348(7 dwts.
168
4.348 grains.

If 1 English bundle of yarn weighs 1 lb., 3 oz., 7 dwts., 4.348 grains, or 1484.848 grains, what numbers will it be?

Dividend.
1 bundle weighs 8484.848 grns.)1400000.000(165's nos. of yarn.
8484848
55151520
50909088
42424320
42424240

How many yards are there in 1 pound of 184's yarn?

184, numbers of yarn.
300 yards are 1 lea of number 1.
55200, number of yards in 1 lb.

Required, the weight of 1 Irish or Scotch hank of number 184's yarn:—

Dividend.
Numbers of yarn, 184)84000(456.52 grains, weight required.
736
1040
920
1200
1104
960
920
400
368
32

Grains. Grains.
1 oz. =437.5)456.52(1 oz., 0 dwts., 19.02 grains, weight required.
437.5
19.02 grains.

Required, the weight of 1 English hank of number 180's yarn:—

Dividend.
Numbers of yarn, 180)70000($388\frac{8}{9}$ grains, weight required.
540

1600
1440

1600
1440

160

1 dwt. is equal to 24 grns.)$388\frac{8}{9}$(16 dwts., $4\frac{8}{9}$ grains, weight required.
24

148
144

4 8-9ths.

Required, the weight of 1 Irish spangle, or Scotch spindle of number 196's:—

Dividend.
Numbers of yarn, 196)336000(1714.285 grains, weight required.
196

1400
1372

280
196

840
784

560
392

1680 1120
1568 980

140

Grains. Grains.
1 oz.=437.5)1714.285(3 oz., 16 dwts., 17.785 grains,
13125 weight required.

1 dwt.=24 grains,)401.785(16 dwts.
24

161
144

17.785 grains.

How many yards are there in 1 oz. of number 196's?
196, numbers, or counts of yarn.
300 yards are 1 lea of number 1's.

1 lb.=16 oz.)58800(3675 yards of nos. 196's in 1 oz.
48

108
96

120
112

80
80

Required, the weight of 1 lea, or cut of number 215's weft:—

Dividend.
Numbers of yarn, 215)7000(32.558 grains, or 1 dwt., 8½ grains,
645 weight required.

550
430

1200
1075

1250
1075

1750
1720

30

Required, the weight of 1 Irish or Scotch hank of number 235's yarn:—

Dividend.
Numbers of yarn, 235)84000(357.446 grains, weight required.
705
―――
1350
1175
―――
1750
1645
―――
1050
940
―――
1100
940
―――
1600
1410
―――
190

$$1\text{ dwt.} = 24\text{ grains, or}\left\{\begin{array}{l} 4)357.446\text{ grains.} \\ \hline 6)89.3615 \end{array}\right.$$

―――
14.89358, or 14 dwts., 21½ grs., nearly.

How many yards are there in 1 pound of number 235's yarn?

235, numbers of yarn.
300 yards 1 lea, or cut of number 1's.
―――
70500 number of yards required.

Required, the weight of 1 Irish bundle of number 130's yarn:—

Dividend.
Numbers of yarn, 130)4200000(32307.692 grs. weight required.
390
300
260
400
390
1000
910
900
780
1200
1170
300
260
40

Grains. Grains.
1 lb. =7000)32307.692(4 lbs., 9 oz., 15 dwts., $10\frac{1}{5}$ grains
28000 nearly, weight required.
1 oz. =437.5 grns.)4307.692(9 oz.
3937.5
1 dwt. =24 grains,)370.192(15 dwts.
24
130
120
10.192 grains.

If 1 Irish bundle of yarn weighs 4 lbs., 9 oz., 15 dwts., 10.192 grains, or 32307.692 grains, what numbers will it be?

```
                        Dividend.
   Weight, 32307.692)4200000.00(130, numbers of yarn.
                     32307692
                     ---------
                      96923080
                      96923076
                      --------
                            40
```

Required, the weight of 1 English hank of number 245's yarn:—

```
                     Dividend.
Numbers of yarn, 245)70000(285.714 grains, weight required.
                     490
                     ----
                     2100
                     1960
                     -----
                      1400
                      1225
                      -----
                       1750
                       1715
                       -----
                         350
                         245
                        -----
                         1050
                          980
                         ----
                           70
```

```
         Grains. Grains.
   1 dwt. =24)285.714(11 dwts., 21¾ grains nearly, weight re-
              24                                       quired.
              ---
               45
               24
              ------
               21.714
```

Required, the weight of 1 Irish or Scotch hank of number 240's yarn:—

24

Dividend.
Numbers of yarn, 240)84000(350 grains, weight required.
720
1200
1200

1 dwt. = 24 grns. { 2)350 grains.
12)175
14 dwts., 14 grs., weight required.

How many yards are there in 1 Irish or Scotch hank of yarn?

300 yards, 1 lea, or cut.
12 leas, or cuts, are 1 Irish or Scotch hank.
3600 yards in 1 Irish or Scotch hank.

Required, the weight of 1 Irish spangle or Scotch spindle of number 265's yarn:—

Dividend.
Numbers of yarn, 265)33600(1267.92 grains, weight required.
265
710
530
1800
1590
2100
1855
2450
2385
650
530
120

Grains. Grains.
1 oz. = 437.5)1267.92(2 oz., 16 dwts., 9 grains nearly, weight required.
875.0

1 dwt. = 24 grs.)392.92(16 dwts.
24

152
144

8.92 grains.

How many yards are there in 1 oz. of number 265's yarn?

265 numbers of yarn.
300 yards, 1 lea or cut.

1 lb. = 16 oz. { 4)79500
4)19875

4968.75, or 4968¾ yards in 1 oz.

Required, the weight of 1 lea, or cut of number 298's yarn?

Dividend.
Numbers of yarn, 298)7000(23.49, or 23½ grains nearly, weight required.
596

1040
894

1460
1192

2680
2682—nearly.

Required, the weight of 1 English bundle of number 295's yarn :—

Dividend.
Numbers of yarn, 295)70000(237.288 grains, weight required.
590
1100
885
2150
2065
850
590
2600
2360
2400
2360
40

1 dwt. = 24 grains)237.288(9 dwts., 21¼ grains, weight required.
216
21.288 grains.

How many yards are there in 1 lb. of number 295's yarn?

295, numbers of yarn.
300 yards in 1 lea or cut.
88500 yards in 1 lb. of number 295's yarn.

In calculating the weight of linen yarns required to produce any fabric of cloth, the rules are the same as those in cotton, with this exception only: 300 yards constitute the lea, or cut in linen, which counts in the numbers of yarn the same as 840 yards in cotton.

What will the weight of a linen warp be, 124 yards long, containing 2160 ends made from 80's yarn?

2160, ends in the warp.
124

8640
4320
2160

1 lea = 3.00 yards)2678.40

Numbers of yarn, 8.0)89.2.8

11.16 lbs.
16 oz. are 1 lb.

96
16

2.56 oz.
4 qrs., 1 oz.

2.24 quarters.

The weight of the warp will be 11 lbs., 2 oz., 2.24 qrs.

If a warp be 34 inches wide at the reed, containing 2160 ends, how many ends will there be in the inch?

34)2160(63.53, or 63½ ends in an inch at the reed.
204

120
102

180
170

100
102—nearly.

What weight of number 95's linen yarn will it require to weave a warp 124 yards long, 34 inches wide, and 76 picks, or threads in an inch?

```
                             124 yards, length of warp.
                              34 inches, width of warp at the
                             ---                         reed.
                             496
                            372
                            ----
                            4216
                              76 picks, or threads in an inch.
                           -----
                           25296
                          29512
                          ------
1 lea is equal to 3.00 yds.)3204.16
                          ------
   Numbers of yarn, 95)1068.0533(11.2426 lbs.
                       95          16 oz. are 1 lb.
                      ---       -----
                      118       14556
                       95       2426
                      ---       -----
                       230      3.8816
                       190           4 qrs. are 1 oz.
                       ---      ------
                        405     3.5264, or 11 lbs., 3 oz.,
                        380             3½ qrs. neat weight
                        ---             required to weave
                         253            the above.
                         190
                         ---
                          633
                          570
                          ---
                           63
```

N. B.—Allowance must be made for waste.

The length and weight of linen yarns required for manufacturing any fabric of linen cloth, may be ascertained in the same manner as illustrated in the two preceding examples.

WORSTED AND WOOLLEN YARNS.

ALL worsted and woollen yarns being sold by the gross, it is necessary that the manufacturer of worsted and woollen pieces be well acquainted with the weight per gross according to the fineness of the yarns, in order to insure the proper weight of the piece he is making. The yarn being too heavy, even if made from wool of a proper quality, gives an inferior appearance.

It is particularly necessary for the spinner to keep a strict check upon the working of his machinery; wool being much sooner affected by the atmosphere than cotton.

The usual plan of trying the fineness of worsted, or woollen yarns is, to weigh 1 hank, and if the result be doubtful, to take a quarter of a gross from each frame, or collectively, as circumstances may require.

The following tables will show the weight of 1 hank, 1 dozen, and 1 gross of worsted, or woollen yarns, from number 1 to 270 hanks in the pound.

If the weight of a less quantity than 1 hank should be required, rules and examples will be found after the next table.

EXPLANATION TO THE FOLLOWING TABLES.

The first and last columns contain the numbers or counts of yarn; opposite to which in the table is the weight according to the length weighed.

560 yards make 1 hank.
12 hanks make 1 dozen.
12 dozens, or 144 hanks make 1 gross.

N. B.—The pounds and ounces are avoirdupois weight; the pennyweights and grains are troy weight.

24 grains are equal to 1 pennyweight.
18 pennyweights, 5½ grains troy are equal to 1 ounce avoirdupois.
16 ounces are equal to 1 lb.

Or,

24 grains make 1 pennyweight.
437½ grains make 1 ounce avoirdupois.
7000 grains make 1 pound avoirdupois.

WORSTED AND WOOLLEN YARN TABLE.

From Number 1 to 40 hanks in the pound.

	Weight of 1 hank.			Weight of 1 dozen.				Weight of 1 gross.				
Nos.	oz.	dwts.	grains.	lbs.	oz.	dwts.	grains.	lbs.	oz.	dwts.	grains.	Nos.
1	16	0	0.	12	0	0	0.	44	0	0	0.	1
2	8	0	0.	6	0	0	0.	72	0	0	0.	2
3	5	6	1.8	4	0	0	0.	48	0	0	0.	3
4	4	0	0.	3	0	0	0.	36	0	0	0.	4
5	3	3	15.5	2	6	7	7.	28	12	14	14.	5
6	2	12	3.6	2	0	0	0.	24	0	0	0.	6
7	2	5	5.	1	11	7	19.5	20	9	2	14.5	7
8	2	0	0.	1	8	0	0.	18	0	0	0.	8
9	1	14	4.2	1	5	6	1.8	16	0	0	0.	9
10	1	10	22.5	1	3	3	15.5	14	6	7	7.	10
11	1	8	6.8	1	1	8	6.8	13	1	8	6.	11
12	1	6	1.8	1	0	0	0.	12	0	0	0.	12
13	1	4	4.9		14	14	0.5	11	1	4	4.9	13
14	1	2	14.5		13	13	0.5	10	4	10	10.	14
15	1	1	5.1		12	14	14.	9	9	10	22.5	15
16	1	0	0.		12	0	0.	9	0	0	0.	16
17		17	3.7		11	5	8.6	8	7	9	15.6	17
18		16	4.8		10	12	3.6	8	0	0	0.	18
19		15	8.4		10	1	22.	7	9	4	19.1	19
20		14	14.		9	10	22.5	7	3	3	15.5	20
21		13	21.3		9	2	14.5	6	13	13	0.5	21
22		13	6.1		8	13	6.1	6	8	13	5.75	22
23		12	16.3		8	6	8.1	6	4	3	4.	23
24		12	3.6		8	0	0.	6	0	0	0.	24
25		11	16.		7	12	9.5	5	12	2	22.	25
26		11	5.2		7	7	0.2	5	8	11	5.2	26
27		10	19.2		7	2	0.6	5	5	6	1.8	27
28		10	10.		6	15	15.	5	2	5	5.	28
29		10	1.3		6	11	7.5	4	15	8	4.1	29
30		9	17.3		6	7	7.	4	12	14	14.	30
31		9	9.8		6	3	12.6	4	10	5	21.1	31
32		9	2.7		6	0	0.	4	8	0	0.	32
33		8	20.1		5	14	21.9	4	5	14	21.6	33
34		8	13.8		5	11	19.	4	3	13	22.5	34
35		8	7.9		5	8	20.5	4	1	15	2.5	35
36		8	2.4		5	6	1.8	4	0	0	0.	36
37		7	21.1		5	3	10.7	3	14	4	22.2	37
38		7	16.2		5	0	23.	3	12	11	12.3	38
39		7	11.4		4	16	19.8	3	11	1	14.45	39
40		7	7.		4	14	14.	3	9	10	22.5	40

If the weight of any shorter length than stated in the preceding table should be required, it may be ascertained by taking the number opposite the length weighed as shown below for a dividend, and the numbers, or counts of yarn for a divisor, and the quotient will be the weight in grains; or, take the number of grains any given length weighs for a divisor, and the number opposite that given length for a dividend, and the quotient will be the numbers, or counts of yarn roving, &c.

	Given lengths. Yards.	Dividends.
1 gross, or	80640	1008000
1 dozen, or	6720	84000
1 hank, or	560	7000
6 leas, or	480	6000
5 leas, or	400	5000
4 leas, or	320	4000
3 leas, or	240	3000
2 leas, or	160	2000
1 lea, or	80	1000
$\frac{3}{4}$ lea, or	60	750
$\frac{1}{2}$ lea, or	40	500
$\frac{1}{4}$ lea, or	20	250
$\frac{1}{8}$ lea, or	10	125
$\frac{1}{16}$ lea, or	5	62.5
$\frac{1}{40}$ lea, or	2	25
$\frac{1}{80}$ lea, or	1	12.5

N. B.—The worsted reel is 2 *yards in circumference, and* 40 *threads round the reel make* 1 *lea, and* 7 *leas make* 1 *hank.*

Required the weight of 40 yards of a hank roving:—

Look opposite 40 yards in the above table, and you will find 500, which is the dividend, and divide by 4, the numbers, or counts of roving, and the quotient will be the weight in grains.

Numbers, or counts of roving, 4 hanks)500 dividend.

125 grains, or 5 pennyweights, 5 grains, weight required.

WORSTED AND WOOLLEN YARN TABLE.

From Number 41 to 80 hanks in the pound.

	Wght. of 1 hnk.		Weight of 1 dozen.			Weight of 1 gross.				
Nos.	dwts.	grains.	oz.	dwts.	grains.	lbs.	oz.	dwts.	grains.	Nos.
41	7	2.7	4	12	10.7	3	8	3	13.3	41
42	6	22.6	4	10	10.	3	6	15	15.	42
43	6	18.7	4	8	11.4	3	5	10	14.3	43
44	6	15.	4	6	15.1	3	4	6	14.8	44
45	6	11.5	4	4	20.6	3	3	3	15.5	45
46	6	8.1	4	3	4.	3	2	1	14.	46
47	6	4.9	4	1	13.2	3	1	0	9.3	47
48	6	1.8	4	0	0.	3	0	0	0.	48
49	5	22.8	3	16	17.7	2	15	0	8.9	49
50	5	20.	3	15	7.5	2	14	1	11.	50
51	5	17.2	3	13	22.5	2	13	3	5.2	51
52	5	14.6	3	12	14.8	2	12	5	14.6	52
53	5	12.	3	11	8.4	2	11	8	14.3	53
54	5	9.6	3	10	3.	2	10	12	15.6	54
55	5	7.2	3	8	22.7	2	9	16	5.7	55
56	5	5.	3	7	19.5	2	9	2	14.5	56
57	5	2.8	3	6	17.1	2	8	7	16.2	57
58	5	0.6	3	5	15.7	2	7	13	4.8	58
59	4	22.6	3	4	15.2	2	7	0	22.2	59
60	4	20.6	3	3	15.5	2	6	7	7.	60
61	4	18.7	3	2	16.5	2	5	14	0.1	61
62	4	16.9	3	1	18.3	2	5	2	22.5	62
63	4	15.1	3	0	20.8	2	4	10	10.	63
64	4	13.3	3	0	0.	2	4	0	0.	64
65	4	11.6	2	17	9.3	2	3	8	3.2	65
66	4	10.	2	16	13.7	2	2	16	13.7	66
67	4	8.4	2	15	18.7	2	2	17	1.7	67
68	4	6.9	2	15	0.3	2	1	16	2.	66
69	4	5.4	2	14	6.4	2	1	7	3.2	69
70	4	4.	2	13	13.	2	0	16	16.	70
71	4	2.6	2	12	20.1	2	0	8	5.1	71
72	4	1.2	2	12	3.6	2	0	0	0.	72
73	3	23.9	2	11	11.6	1	15	10	5.7	73
74	3	22.6	2	10	20.1	1	15	2	11.1	74
75	3	21.3	2	10	5.	1	14	13	3.	75
76	3	20.1	2	9	14.2	1	14	5	18.1	76
77	3	18.9	2	8	23.9	1	13	16	19.4	77
78	3	17.7	2	8	9.9	1	13	9	19.5	78
79	3	16.6	2	7	20.3	1	13	3	0.	79
80	3	15.5	2	7	7.	1	12	14	14.	80

Required, the weight of 1 lea of number 36's yarn:—

Look opposite 1 lea, or 80 yards, and you will find 1000 which is the dividend, the numbers of yarn, *i. e.*, 36's will be the divisor, and the quotient will be the weight in grains.

Dividend.
Numbers of yarn, 36's)1000(27.77 grains, or 1 dwt., 3¾ grains, weight required.
72
280
252
280
252
280
252
28

If 1 lea, or 80 yards of yarn weigh 27.77 grains; what numbers, or counts will it be?

1000 is the dividend for 1 lea, or 80 yards.
Weight of 1 lea, 27.77 grs.)1000.00(36, numbers, or counts of yarn.
8333
16666
16666

Required, the weight of 1 hank of number 80's yarn:—

7000 is the dividend for 1 hank, or 560 yards.
Numbers of yarn, 8.0)700.0
87.5 grains, or 3 dwts., 15½ grains weight required.

If 1 hank, or 560 yards, weigh 3 dwts., 15½ grains, or 87.5 grains; what numbers will it be?

7000 is the dividend for 1 hank, or 560 yards.
Weight of 1 hk. 87.5 grs.)7000.0(80, number of counts of yarn.
7000
0

N. B.—The above examples will be sufficient to illustrate the tables; but if more should be required, see cotton, the only difference being the length constituting the hank.

WORSTED AND WOOLLEN YARNS.

From Number 80 to 120 hanks in the pound.

	Wgt. of 1 hk.		Weight of 1 dozen.			Weight of 1 gross.				
Nos.	dwts.	grains.	oz.	dwts.	grains.	lbs.	oz.	dwts.	grains.	Nos.
81	3	14.4	2	6	18.	1	12	8	2.4	81
82	3	13.3	2	6	5.4	1	12	1	18.6	82
83	3	12.3	2	5	17.	1	11	13	20.	83
84	3	11.3	2	5	5.	1	11	7	20.5	84
85	3	10.3	2	4	17.2	1	11	1	22.3	85
86	3	9.4	2	4	5.7	1	10	14	9.9	86
87	3	8.4	2	3	18.5	1	10	8	19.2	87
88	3	7.5	2	3	7.5	1	10	3	7.5	88
89	3	6.6	2	2	20.8	1	9	16	4.3	89
90	3	5.7	2	2	10.3	1	9	10	22.5	90
91	3	4.9	2	2	0.	1	9	5	19.4	91
92	3	4.	2	1	14.	1	9	0	19.	92
93	3	3.2	2	1	4.2	1	8	14	2.7	93
94	3	2.4	2	0	18.6	1	8	9	7.4	94
95	3	1.6	2	0	9.2	1	8	4	14.5	95
96	3	0.9	2	0	0.	1	8	0	0.	96
97	3	0.1	1	17	20.4	1	7	13	17.2	97
98	2	23.4	1	17	11.6	1	7	9	7.2	98
99	2	22.7	1	17	2.9	1	7	4	23.3	99
100	2	22.	1	16	18.5	1	7	0	18.	100
101	2	21.3	1	16	10.1	1	6	14	14.1	101
102	2	20.6	1	16	2.	1	6	10	17.3	102
103	2	19.9	1	15	18.	1	6	6	17.4	103
104	2	19.3	1	15	10.2	1	6	2	19.3	104
105	2	18.6	1	15	2.5	1	5	17	4.5	105
106	2	18.	1	14	18.9	1	5	13	9.9	106
107	2	17.4	1	14	11.5	1	5	9	17.	107
108	2	16.8	1	14	4.2	1	5	6	1.8	108
109	2	16.2	1	13	21.1	1	5	2	12.2	109
110	2	15.6	1	13	14.1	1	4	17	5.6	110
111	2	15.	1	13	7.2	1	4	13	19.	111
112	2	14.5	1	13	0.5	1	4	10	10.	112
113	2	13.9	1	12	17.8	1	4	7	2.3	113
114	2	13.4	1	12	11.3	1	4	3	20.1	114
115	2	12.8	1	12	4.9	1	4	0	15.2	115
116	2	12.3	1	11	22.6	1	3	15	17.1	116
117	2	11.8	1	11	16.4	1	3	12	14.8	117
118	2	11.3	1	11	10.3	1	3	9	13.8	118
119	2	10.8	1	11	4.3	1	3	6	14.	119
120	2	10.3	1	10	22.5	1	3	3	15.5	120

Required, the length and weight of number 56's yarn, for a warp 128 yards long, 36 inches wide at the reed, and to have 84 threads in an inch:—

128 yards, length of warp.
36 inches, width of warp at the reed.
768
384
4608
84, threads in an inch.
18432
36864
387072, total No. of yds. of yarn in the warp.

Yards.
1 gross contains 80640 yds.)387072(4 gross.
322560
1 dozen contains 6720 yds.)64512(9 dozen.
60480
1 hank contains 560 yds.)4032(7 hanks.
3920
1 lea contains 80 yds.)112(1 lea.
80
1 thread contains 2 yds.)32
16 threads.

The length of yarn required for the above warp will be 4 gross, 9 dozen, 7 hanks, 1 lea, and 16 threads.

560 yards, 1 hank.
56, numbers of yarn.
3360
2800
31360 number of yards in 1 lb., of 56's yarn.

WORSTED AND WOOLLEN YARN TABLE.

From Number 121 to 160 hanks in the pound.

	Wght. of 1 hnk.		Weight of 1 dozen.			Weight of 1 gross.				
Nos.	dwts.	grains.	oz.	dwts.	grains.	lbs.	oz.	dwts.	grains.	Nos.
121	2	9.8	1	10	16.7	1	3	0	18.	121
122	2	9.3	1	10	11.	1	2	16	3.3	122
123	2	8.9	1	10	5.4	1	2	13	8.1	123
124	2	8.4	1	9	23.9	1	2	10	5.9	124
125	2	8.	1	9	18.5	1	2	7	21.	125
126	2	7.5	1	9	13.1	1	2	5	5.	126
127	2	7.1	1	9	7.9	1	2	2	14.	127
128	2	6.6	1	9	2.7	1	2	0	0.	128
129	2	6.2	1	8	21.6	1	1	15	16.4	129
130	2	5.8	1	8	16.6	1	1	13	4.3	130
131	2	5.4	1	8	11.7	1	1	10	17.1	131
132	2	5.	1	8	6.8	1	1	8	6.8	132
133	2	4.6	1	8	2.	1	1	5	20.7	133
134	2	4.2	1	7	21.3	1	1	3	12.8	134
135	2	3.8	1	7	16.7	1	1	1	5.1	135
136	2	3.4	1	7	12.1	1	0	17	3.7	136
137	2	3.1	1	7	7.6	1	0	14	21.6	137
138	2	2.7	1	7	3.2	1	0	12	16.3	138
139	2	2.3	1	6	22.8	1	0	10	11.8	139
140	2	2.	1	6	18.5	1	0	8	8.	140
141	2	1.6	1	6	14.2	1	0	6	4.9	141
142	2	1.3	1	6	10.	1	0	4	2.5	142
143	2	1.	1	6	5.9	1	0	2	0.9	143
144	2	0.6	1	6	1.8	1	0	0	0.	144
145	2	0.2	1	5	21.8		15	16	5.2	145
146	1	23.9	1	5	17.8		15	14	5.6	146
147	1	23.6	1	5	13.9		15	12	6.6	147
148	1	23.3	1	5	10.		15	10	8.3	148
149	1	23.	1	5	6.2		15	8	10.6	149
150	1	22.6	1	5	2.5		15	6	13.5	150
151	1	22.3	1	4	22.8		15	4	16.9	151
152	1	22.	1	4	19.1		15	2	21.	152
153	1	21.7	1	4	15.5		15	1	1.7	153
154	1	21.4	1	4	11.9		14	17	12.4	154
155	1	21.1	1	4	8.4		14	15	18.3	155
156	1	20.8	1	4	4.9		14	14	0.5	156
157	1	20.5	1	4	1.5		14	12	7.3	157
158	1	20.3	1	3	22.1		14	10	14.7	158
159	1	20.	1	3	18.8		14	8	22.6	159
160	1	19.7	1	3	15.5		14	7	7.	160

Yards. Yards in the warp.
1 lb. of No. 56's = 31360)387072(12.34 lbs., or 12 lbs., 5½ oz.
31360 16 oz., 1 lb.

73472 204
62720 34

107520 5.44 oz.
94080 4 qrs., 1 oz.

134400 1.76 qrs.
125440—8960, remainder.

The weight of yarn required for the above warp will be 12 lbs., 5½ oz. nearly.

Required, the weight of number 66's yarn, to weave a warp 128 yards long, 36 inches wide at the reed, and to have 88 picks, or threads in an inch:—

128 yards, length of warp.
36 inches, width of warp at the reed.

768
384

4608
88, number of picks, or threads in an inch.

36864
36864

405504 No. of yds. of yarn required to weave the warp.

Yards. Yards.
1 gross contains 80640)405504(5 gross, 4 hanks, and 32 threads,
403200 length of yarn required to weave the warp.

1 hank contains 560 yds.)2304(4 hanks.
2240

1 thread contains 2 yards,)64

32 threads.

560 yards, 1 hank.
66, numbers of yarn.

3360
3360

36960, number of yards in 1 lb. of 66's yarn.

WORSTED AND WOOLLEN YARN TABLE.

From Number 161 to 200 hanks in the pound.

	Weight of 1 hank.			Weight of 1 dozen.				Weight of 1 gross.				
Nos.	oz.	dwt.	grains.	lbs.	oz.	dwts.	grains.	lbs.	oz.	dwts.	grains.	Nos.
161		1	19.4		1	3	12.2		14	5	15.8	161
162		1	19.2		1	3	9.		14	4	1.2	162
163		1	18.9		1	3	5.8		14	2	11.	163
164		1	18.6		1	3	2.7		14	0	21.3	164
165		1	18.4		1	2	23.6		13	17	13.6	165
166		1	18.1		1	2	20.5		13	16	0.7	166
167		1	17.9		1	2	17.5		13	14	12.4	167
168		1	17.6		1	2	14.5		13	13	0.5	168
169		1	17.4		1	2	11.5		13	11	13.	169
170		1	17.1		1	2	8.6		13	10	1.9	170
171		1	16.9		1	2	5.7		13	8	15.2	171
172		1	16.7		1	2	2.8		13	7	4.9	172
173		1	16.4		1	2	0.		13	5	19.	173
174		1	16.2		1	1	21.2		13	4	9.6	174
175		1	16.		1	1	18.5		13	3	0.5	175
176		1	15.7		1	1	15.7		13	1	15.7	176
177		1	15.5		1	1	13.		13	0	7.4	177
178		1	15.3		1	1	10.4		12	17	4.9	178
179		1	15.1		1	1	7.7		12	15	21.2	179
180		1	14.8		1	1	5.1		12	14	14.	180
181		1	14.6		1	1	2.5		12	13	7.	181
182		1	14.5		1	1	0.		12	12	0.4	182
183		1	14.2		1	0	21.5		12	10	18.1	183
184		1	14.		1	0	19.		12	9	12.2	184
185		1	13.8		1	0	16.5		12	8	6.6	185
186		1	13.6		1	0	14.1		12	7	1.3	186
187		1	13.4		1	0	11.7		12	5	20.3	187
188		1	13.2		1	0	9.3		12	4	15.7	188
189		1	13.		1	0	6.9		12	3	11.3	189
190		1	12.8		1	0	4.6		12	2	7.2	190
191		1	12.6		1	0	2.3		12	1	3.4	191
192		1	12.4		1	0	0.		12	0	0.	192
193		1	12.2			18	3.2		11	17	2.3	193
194		1	12.			18	0.9		11	15	23.3	194
195		1	11.8			17	22.7		11	14	20.7	195
196		1	11.7			17	20.5		11	13	18.3	196
197		1	11.5			17	18.4		11	12	16.2	197
198		1	11.3			17	16.2		11	11	14.4	198
199		1	11.1			17	14.1		11	10	12.8	199
200		1	11.			17	12.		11	9	11.5	200

Yards. Yards in the warp.
1 lb. of No. 66's = 36960)405504(10 lbs., 15½ oz., wt. of weft required to weave the warp.
36960
35904
16 oz. 1 lb.
215424
35904
36960)574464(15 oz.
36960
204864
184800
20064
4 qrs., 1 oz.
36960)80256(2 qrs.
73920
6336

If it requires 12 lbs., 5½ oz. of yarn for a warp, and 10 lbs., 15½ oz. of yarn to weave the warp; what weight will it require for 1 piece, if there be 4 pieces in the warp?

lbs. oz.
12 . . 5½, weight of the warp.
10 . . 15½, weight to weave the warp.
No. of pieces in warp, 4)23 . . 5
5 . . 13¼, weight of 1 piece.

N. B.—The rules, examples, and illustrations laid down for the manufacture of cotton goods, may be applied to the manufacture of any other fabric of cloth, such as linen, worsted, woollen, or silk; the system of calculation being the same, with the exception of the length constituting the lea and hank, all particulars of which will be found in their proper places in this book.

WORSTED AND WOOLLEN YARN TABLE.

From Number 201 to 270 hanks in the pound.

	Wgt. of 1 hank.		Weight of 1 dozen.			Weight of 1 gross.				
Nos.	dwts.	grains.	oz.	dwts.	grains.	lbs.	oz.	dwts.	grains.	Nos.
201	1	10.8		17	9.9		11	8	10.4	201
202	1	10.6		17	7.8		11	7	9.6	202
203	1	10.4		17	5.8		11	6	9.	203
204	1	10.3		17	3.7		11	5	8.6	204
205	1	10.1		17	1.7		11	4	8.5	205
206	1	9.9		16	23.7		11	3	8.7	206
207	1	9.8		16	21.8		11	2	9.	207
208	1	9.6		16	19.8		11	1	9.6	208
209	1	9.4		16	17.9		11	0	10.4	209
210	1	9.3		16	16.		10	17	17.	210
211	1	9.1		16	14.1		10	16	18.2	211
212	1	9.		16	12.2		10	15	19.7	212
213	1	8.8		16	10.3		10	14	21.3	213
214	1	8.7		16	8.5		10	13	23.2	214
215	1	8.5		16	6.7		10	13	1.3	215
216	1	8.4		16	4.8		10	12	3.6	216
217	1	8.2		16	3.1		10	11	6.1	217
218	1	8.1		16	1.3		10	10	8.8	218
219	1	7.9		15	23.5		10	9	11.7	219
220	1	7.8		15	21.8		10	8	14.8	220
221	1	7.6		15	20.1		10	7	18.	221
222	1	7.5		15	18.3		10	6	21.5	222
223	1	7.3		15	16.6		10	6	1.1	223
224	1	7.2		15	15.		10	5	5.	224
225	1	7.1		15	13.3		10	4	9.	225
226	1	6.9		15	11.6		10	3	13.1	226
227	1	6.8		15	10.		10	2	17.5	227
228	1	6.7		15	8.4		10	1	22.	228
229	1	6.5		15	6.8		10	1	2.7	229
230	1	6.4		15	5.2		10	0	7.6	230
231	1	6.3		15	3.6		9	17	18.1	231
232	1	6.1		15	2.		9	16	23.3	232
235	1	5.7		14	21.4		9	14	15.8	235
240	1	5.1		14	14.		9	10	22.5	240
245	1	4.5		14	6.8		9	7	8.7	245
250	1	4.		14	0.		9	3	22.5	250
255	1	3.4		13	17.4		9	0	15.4	255
260	1	2.9		13	11.		8	15	16.9	260
265	1	2.4		13	5.		8	12	15.7	265
270	1	1.9		12	23.1		8	9	17.3	270

WORSTED COUNT OF REEDS.

The following are the general acknowledged methods of counting and expressing reeds in the manufacturing of all worsted goods.

1st. The plain back, or three ends in a dent, the counts, or fineness of the set, which is expressed by the number of scores, or beers, 20 dents to a beer set on 6-4ths, or 54 inches at the reed. Thus, a 42 contains 42 scores, or 42 beers, 20 dents to a beer, or 840 dents on 54 inches at the reed.

N. B.—This reed is the most common one in use at the present time.

2d. The wildbore, or 4 ends in a dent, the count, or fineness of the set, which is expressed by the number of scores, or beers, 20 dents to a beer, set on 8-4ths, or 72 inches at the reed. Thus, a 50 wildbore slaie, or reed, contains 50 scores, or 50 beers, 20 dents to a beer, or 1000 dents on 72 inches at the reed.

N. B.—This method is very little in use now.

3d. The 2 ends in a dent is coming more into use, the fineness of the set, which is expressed by the number of scores, or beers, 20 dents to a beer set on 4-4ths or 36 inches at the reed.

4th. Lastings. The count, or fineness of the set, which is expressed by the number of dents set on 30 inches at the reed. Thus a 4 contains 400 dents, a 4½ contains 450 dents, &c. &c.

The following tables will show the count, or fineness of worsted reeds, according to the number of dents in an inch, and the different systems of counting.

EXPLANATION TO THE REED TABLES.

The first line in each division contains the number of dents in an inch; opposite to which in the table is the count of the reed, according to the different systems of counting.

N. B.—The decimal in the line expressing the number of dents in an inch, is the decimal of a dent. Thus, 20.5 *is equal to* 20½ *dents, and the decimal in the lines expressing the counts of the reeds, is the decimal of a score, or beer containing* 20 *dents. Thus,* 40.5 *is equal to* 40½ *scores, or beers.*

WORSTED REED TABLE.

Dents in 1 inch.	Scores, or beers on 54 inches.	Scores, or beers on 72 inches.	Scores, or beers on 36 inches.	Dents on 30 inches.	Dents in 1 inch.	Scores, or beers on 54 inches.	Scores, or beers on 72 inches.	Scores, or beers on 36 inches.	Dents in 30 inches.
8.	21.6	28.8	14.4	240	25.5	68.85	91.8	45.9	765
8.5	22.95	30.6	15.3	255	26.	70.2	93.6	46.8	780
9.	24.3	32.4	16.2	270	26.5	71.55	95.4	47.7	795
9.5	25.65	34.2	17.1	285	27.	72.9	97.2	48.6	810
10.	27.	36.	18.	300	27.5	74.25	99.	49.5	825
10.5	28.35	37.8	18.9	315	28.	75.6	100.8	50.4	840
11.	29.7	39.6	19.8	330	28.5	76.95	102.6	51.3	855
11.5	31.05	41.4	20.7	345	29.	78.3	104.4	52.2	870
12.	32.4	43.2	21.6	360	29.5	79.65	106.2	53.1	885
12.5	33.75	45.	22.5	375	30.	81.	108.	54.	900
13.	35.1	46.8	23.4	390	30.5	82.35	109.8	54.9	915
13.5	36.45	48.6	24.3	405	31.	83.7	111.6	55.8	930
14.	37.8	50.4	25.2	420	31.5	85.05	113.4	56.7	945
14.5	39.15	52.2	26.1	435	32.	86.4	115.2	57.6	960
15.	40.5	54.	27.	450	32.5	87.75	117.	58.5	975
15.5	41.85	55.8	27.9	465	33.	89.1	118.8	59.4	990
16.	43.2	57.6	28.8	480	33.5	90.45	120.6	60.3	1005
16.5	44.55	59.4	29.7	495	34.	91.8	122.4	61.2	1020
17.	45.9	61.2	30.6	510	34.5	93.15	124.2	62.1	1035
17.5	47.25	63.	31.5	525	35.	94.5	126.	63.	1050
18.	48.6	64.8	32.4	540	35.5	95.85	127.8	63.9	1065
18.5	49.95	66.6	33.3	555	36.	97.2	129.6	64.8	1080
19.	51.3	68.4	34.2	570	36.5	98.55	131.4	65.7	1095
19.5	52.65	70.2	35.1	585	37.	99.9	133.2	66.6	1110
20.	54.	72.	36.	600	37.5	101.25	135.	67.5	1125
20.5	55.35	73.8	36.9	615	38.	102.6	136.8	68.4	1140
21.	56.7	75.6	37.8	630	38.5	103.95	138.6	69.3	1155
21.5	58.05	77.4	38.7	645	39.	105.3	140.4	70.2	1170
22.	59.4	79.2	39.6	660	39.5	106.65	142.2	71.1	1185
22.5	60.75	81.	40.5	675	40.	108.	144.	72.	1200
23.	62.1	82.8	41.4	690	40.5	109.35	145.8	72.9	1215
23.5	63.45	84.6	42.3	705	41.	110.7	147.6	73.8	1230
24.	64.8	86.4	43.2	720	41.5	112.05	149.4	74.7	1245
24.5	66.15	88.2	44.1	735	42.	113.4	151.2	75.6	1260
25.	67.5	90.	45.	750	42.5	114.75	153.	76.5	1275

To ascertain the count, or fineness of worsted reeds.

RULE.—Multiply the number of dents in an inch by the given number of inches any reed is set on, according to the system of counting, and divide by 20, which is the number of dents in a score, or beer, and the quotient will be the count, or fineness of the reed, and if the number of dents in an inch at the reed be required, multiply the count of the reed by 20, and divide by the given number of inches the reed is set on, and the quotient will be the number of dents in an inch, according to the fineness of the reed, and the system of counting.

The system of ascertaining the count, or fineness of reeds for lastings, differs from the others, but will be found by multiplying the number of dents in an inch by 30, the product of which will be the count, or fineness of the reed, and if the number of dents in an inch be required, divide the count, or fineness of the reed by 30, and the quotient will be the number of dents in an inch, according to the fineness of the reed.

EXAMPLES.

The count, or fineness of the plain back reed containing 19 dents in an inch is required:—

19, dents in an inch.
54, number of inches the reed is set on.

76
95

Score, or beer, 2.0 dents,)102.6

51.3, or 51 scores, or beers, and 6 dents set on 54 inches at the reed, or nearly 51½ count, or fineness of the reed.

What number of dents will there be in an inch of a 51.3 plain back reed?

51.3, count of reed.
20 dents, 1 score, or beer.

No. of inches reed set on, 54)1026.0(19, number of dents in an inch at the reed.
54

486
486

WORSTED REED TABLE.

Dents in 1 inch.	Scores, or beers on 54 inches.	Scores, or beers on 72 inches.	Scores, or beers on 36 inches.	Dents on 30 inches.	Dents in 1 inch.	Scores, or beers on 54 inches.	Scores, or beers on 72 inches.	Scores, or beers on 36 inches.	Dents on 30 inches.
43.	116.1	154.8	77.4	1290	60.5	163.35	217.8	108.9	1815
43.5	117.45	156.6	78.3	1305	61.	164.7	219.6	109.8	1830
44.	118.8	158.4	79.2	1320	61.5	166.05	221.4	110.7	1845
44.5	120.15	160.2	80.1	1335	62.	167.4	223.2	111.6	1860
45.	121.5	162.	81.	1350	62.5	168.75	225.	112.5	1875
45.5	122.85	163.8	81.9	1365	63.	170.1	226.8	113.4	1890
46.	124.2	165.6	82.8	1380	63.5	171.45	228.6	114.3	1905
46.5	125.55	167.4	83.7	1395	64.	172.8	230.4	115.2	1920
47.	126.9	169.2	84.6	1410	64.5	174.15	232.2	116.1	1935
47.5	128.25	171.	85.5	1425	65.	175.5	234.	117.	1950
48.	129.6	172.8	86.4	1440	65.5	176.85	235.8	117.9	1965
48.5	130.95	174.6	87.3	1455	66.	178.2	237.6	118.8	1980
49.	132.3	176.4	88.2	1470	66.5	179.55	239.4	119.7	1995
49.5	133.65	178.2	89.1	1485	67.	180.9	241.2	120.6	2010
50.	135.	180.	90.	1500	67.5	182.25	243.	121.5	2025
50.5	136.35	181.8	90.9	1515	68.	183.6	244.8	122.4	2040
51.	137.7	183.6	91.8	1530	68.5	184.95	246.6	123.3	2055
51.5	139.05	185.4	92.7	1545	69.	186.3	248.4	124.2	2070
52.	140.4	187.2	93.6	1560	69.5	187.65	250.2	125.1	2085
52.5	141.75	189.	94.5	1575	70.	189.	252.	126.	2100
53.	143.1	190.8	95.4	1590	70.5	190.35	253.8	126.9	2115
53.5	144.45	192.6	96.3	1605	71.	191.7	255.6	127.8	2130
54.	145.8	194.4	97.2	1620	71.5	193.05	257.4	128.7	2145
54.5	147.15	196.2	98.1	1635	72.	194.4	259.2	129.6	2160
55.	148.5	198.	99.	1650	72.5	195.75	261.	130.5	2175
55.5	149.85	199.8	99.9	1665	73.	197.1	262.8	131.4	2190
56.	151.2	201.6	100.8	1680	73.5	198.45	264.6	132.3	2205
56.5	152.55	203.4	101.7	1695	74.	199.8	266.4	133.2	2220
57.	153.9	205.2	102.6	1710	74.5	201.15	268.2	134.1	2235
57.5	155.25	207.	103.5	1725	75.	202.5	270.	135.	2250
58.	156.6	208.8	104.4	1740	75.5	203.85	271.8	135.9	2265
58.5	157.95	210.6	105.3	1755	76.	205.2	273.6	136.8	2280
59.	159.3	212.4	106.2	1770	76.5	206.55	275.4	137.7	2295
59.5	160.65	214.2	107.1	1785	77.	207.9	277.2	138.6	2310
60.	162.	216.	108.	1800	77.5	209.25	279.	139.5	2325

The count, or fineness of a wildbore reed containing 19 dents in an inch, is required:—

19 dents in an inch.
72, number of inches the reed is set on.

38
133

Score, or beer, 2.0 dnts.)136.8

68.4 count, or fineness of the reed, *i. e.*,
68 scores, or beers, and 8 dents, or
1368 dents set on 72 inches at the reed.

What number of dents will there be in an inch of 68.4 wildbore reed?

68.4, count of reed.
20 dents, 1 score, or beer.

No. of inches reed set on, 72)1368.0(19, number of dents in an
72 inch at the reed.

648
648

The count, or fineness of a reed, is required from the following particulars:—

Number of inches the reed is set on, 36.
Number of dents in an inch, 19.
Number of dents in a score, or beer, 20.

19 dents in an inch.
36, number of inches the reed is set on.

114
57

Score, or beer, 2.0 dnts.)68.4

34.2, count, or fineness of the reed, *i. e.*,
34 scores, or beers, and 4 dents, set on 36 inches at the reed.

If 34 scores, or beers, and 4 dents be set on 36 inches at the reed, how many dents will there be in an inch?

Beers. Dents.
34 . . 4
20, number of dents in a beer.

No. of inches reed set on, 36)684(19, number of dents in an inch at the reed.
36

324
324

The count, or fineness of lasting reed containing 19 dents in an inch, is required :—

19 dents in an inch.
30, number of inches the reed is set on.

570, or nearly 5¾ count, or fineness of the reed.

If a lasting reed contains 570 dents, how many dents will there be in an inch?

No. of inches reed set on, 3.0)57.0 dents.

19, number of dents in an inch at the reed.

How many dents will there be in an inch of a 50 plain back reed?

50, count of reed.
20 dents, 1 score, or beer.

No. of inches reed set on, 54)1000(18.518, or rather more than 18½ dents in an inch at the reed.
54

460
432

280
270

100
54

460
432

28

N. B.—Warps are warped quite independent of the set for which they may be used. The common way of warping is by portits, portives, porters, or beers, whichever they may be called. Some warp by 48 *ends, and lasting warps are generally warped by* 48. *Of course it does not matter in what numbers they are warped, if the warp only contains the number of ends required, according to the width and fineness of the reed.*

MISCELLANEOUS QUESTIONS.

The revolutions a minute of a shaft are required from the following particulars:—

Double strokes of steam engine, 19½ per minute.

Wheel on crank, or fly-shaft, 64 teeth, working into a wheel 49 teeth on the first line of shafts.

Wheel 63 teeth on the first line of shafts, works into a wheel 36 teeth on foot of an upright shaft. Then, wheel 70 teeth on the top of the upright shaft, works into a wheel 39 teeth on lying shaft; the speed of which is required.

Driving-wheels, &c.
19.5 double strokes, engine makes a minute.
64 teeth, wheel on fly, or crank shaft.

780
1170

1248.0
63 teeth, wheel on first lying shaft.

3744
7488

78624
70 teeth, wheel on top of upright shaft.

5503680 dividend.

Driven-wheels.
49 teeth, wheel on first lying shaft.
36 teeth, wheel on foot of upright shaft.

294
147

1764
39 teeth, wheel on lying shaft, the speed of which is required.

15876
5292

68796 divisor.

68796)5503680(80 revolutions per minute, speed of shaft required.
550368

0

Suppose a shaft be making 80 revolutions a minute, with the following driving and driven-wheels on the intermediate shafts; what number of double strokes per minute should the engine make?

Driving-wheels, &c.
80, revolutions of given shaft per minute.
39 teeth, wheel on do.

720
240

3120
36 teeth, wheel on foot of upright shaft.

18720
9360

112320
49 teeth, wheel on the first lying shaft.

1010880
449280

5503680 dividend.

Drivenw-heels.
70 teeth, wheel on top of upright shaft.
63 teeth, wheel on first lying shaft.

210
420

4410
64 teeth, wheel on crank, or fly shaft.

17640
26460

282240 divisor.

282240)5503680(19.5, double strokes of steam-engine a minute.
282240

2681280
2540160

1411200
1411200

If a drum 42¼ inches diameter, drives the beaters of a blowing-machine 1344 revolutions per minute, what must the diameter of a drum be, for the beaters to make 1560 revolutions; and if the present drum is to be lagged, what thickness must the lags be?

Revols. Inches. Revols.
If 1344 : 42.25 :: 1560
1560

253500
21125
4225

1344)65910.00(49.04 inches, diameter of drum required.
5376

12150
12096

5400
5376

24

49.04 inches, diameter of drum required.
42.25 inches, diameter of given drum.

2)6.79 inches, difference of diameters of drums.

3.395, or nearly 3.4 inches, thickness of lags required.

If a drum $42\frac{1}{4}$ inches diameter drives the beater of a blowing-machine 1344 revolutions per minute; what number of revolutions will the beater make if driven from a drum $49\frac{1}{25}$ inches diameter?

Inches. Revols. Inches.
If $42\frac{1}{4}$ or 42.25 : 1344 :: 49.04, or $49\frac{1}{25}$
49.04

5376
120960
5376

42.25)65909.76(1560, revolutions of beater a minute, nearly.
4225

23659
21125

25347
25350—nearly.

If a pulley 13 inches diameter drives the main cylinder of a carding-engine, at the rate of 126 revolutions a minute; what diameter must the pulley be, to reduce the speed of the cylinder to 112 revolutions?

126, revolutions given.
13 inches, diameter of given pulley.

378
126

1638

Revolutions req'd, 112)1638(14.625, or 14$\frac{5}{8}$ inches, diameter of pulley required.
112
518
448
700
672
280
224
560
560

How many grains will 30 yards of 3$\frac{1}{4}$ hank roving weigh?

Hank roving, 3.25)250.00(76.92 grains, or 3 dwts., 5 grains, nearly.
2275
2250
1950
3000
2925
750
650
100

If 30 yards, or $\frac{1}{4}$ of a lea weigh 76.92 grains, what hank roving will it be?

30 yards of roving weigh 76.92)250.00(3.25, or 3$\frac{1}{4}$ hank roving
23076
19240
15384
38560
38460
100

The weight of 1 pair of sets of cops is required from the following particulars:—

Number of spindles in pair of wheels, 1016.
Length of stretch put up (breakage allowed), 61½ inches.
Number of stretches, 900.
Number of yarn 36's.
1016 × 900 × 61.5 = 56235600.0 dividend.
840 × 36 × 36 = 1088640, divisor.
56235600 divided by 1088640 = 51 lbs., 10½ oz., weight of pair of sets.

How many hanks, leas, and yards, will there be in a pair of sets of cops, of which the following are the particulars?

Number of spindles in wheels, 808.
Number of stretches on set, 450.
Net length of stretch put up, 57½ inches.

808, number of spindles in wheels.
450, stretches on set.
40400
3232
363600
57.5, or 57½ inches, length of stretch put up.
1818000
2545200
1818000
1 yard, 36 inches, { 6)20907000.0 number of inches on pair of sets.
6)3484500
1 lea is 12.0 yards,)58075.0 yards.
1 hank is 7 leas,)4839 leas, and 70 yards.
691 hanks, 2 leas, and 70 yards, length on pair of sets.

If there be 691 hanks, 2 leas, and 70 yards on 1 pair of sets of number 36's pincop weft; what weight will they be?

1 lea is 12.0 yards,)70.0 yards.

1 hank is 7 leas,)2.5833 leas.

691.36904 hanks, divided by 36=19 lbs., 3¼ oz., weight of 691 hanks, 2 leas, and 70 yards of 36's weft.

If 20 ounces of cotton were fed on 30 inches of feed-cloth at lap-machine, and to pass through all the operations of working without loss; what numbers of yarn would it produce, allowing the following draughts and doublings?

437.5 grains, 1 oz.
20 ounces, weight of cotton fed on feed-cloth.
Draught at lap-machine, 2)8750.0 grains, do.

Dght. at card. engine, 12.0)437.5 grains, weight of 30 inches of lap.
36.458333 grains, weight of 30 in. of carding.
No. of ends put up at 1st drawing, 6

Dght. 1st hd. of drng., 6.22)218.750000(35 grains weight of 30 inches, at the 1st head of drawings.
1875
3125
3125

35 grs., wgt. of 30 in. of drng. 1st head.
6, No. of ends put up at 2d hd. of drngs.

Draught at the 2d head of drawings, 6.3)210(33.33 grains, weight of 30 inches of drawing at 2d head.
189
210
189
21

33.33 grs. wgt. of 30 in. drng. 2d hd.
8, number of ends put up at 3d head of drawings.

Dght. at 3d hd. drngs., 6.4)266.66(41.666 grs., weight of 30 inches of drawing at 3d head.
256

106
64

426
384

426
384

426
384

42

Dght. at slabbing frame, 5)41.66 grains, weight of 30 inches of drawing, 3d head.

8.33 grs., wgt. of 30 in. of slabbing.
2, no. of ends put up at rov. frame.

Draught at roving frame, 7)16.66

2.38095 grains, weight of 30 inches of roving.

Grains.
Draught at spinning, 11.5)2.38095(.20704, decimal of a grain weight, of 30 inches of yarns.
230

809
805

450
460—nearly.

.20704 grain, weight of 30 inches of yarn.
36, a multiplier for 30 yards.

124224
62112

7.45344 grains, weight of 30 yards of yarn.
4—4 times 30 yards = 1 lea.

29.81376 grains, weight of 1 lea of yarn.

The weight of cotton, according to the foregoing draughts and doublings, required to produce 1 lea of yarn is 29.81376 grains, or 1 dwt., 5.81376 grains.

Weight of 1 lea, 29.81376 grns.)1000.00000(33.54 hanks in 1 lb.
8944128

10558720
8944128

16145920
14906880

12390400
11925504

464896

33.54 hanks = 1 lb.
8.385 hanks = 4 ounces.

41.925 hanks = 20 ounces.
7 leas = 1 hank.

293.475
29.8137 grains = 1 lea.

2054325
880425
293475
2347800
2641275
586950

8749.5756075 grains weight, or 20 ounces fed on 30 inches of feed cloth at lap machine.

If 20 ounces of cotton fed on 30 inches of feed cloth at lap machine produces number 36's twist, or weft, according to the following draughts and doublings; what will the loss sustained in working be?

Draught at the lap machine, 2.
Draught at the carding engine, 120.
Draught at the 1st head of drawings, 6.25.
Draught at the 2d head of drawings, 6.3.
Draught at the 3d head of drawings, 6.4.
Draught at the slabbing frame, 5.
Draught at the roving frame, 7.
Draught at the spinning, 11.5.
Multiplier for 30 inches, 6.944.

Doublings at the 1st head of drawings, 6.
Doublings at the 2d head of drawings, 6.
Doublings at the 3d head of drawings, 8.
Doublings at the roving frame, 2.
Numbers of yarn produced, 36's.

Draughts.
2, lap machine.
120, carding engine.

240
6.25, first head of drawings.

1200
480
1440

1500.00
6.3, second head of drawings.

4500
9000

9450.0
6.4, third head of drawings.

37800
56700

60480.0
5, slabbing frame.

302400
7, roving frame.

2116800
11.5 mules.

10584000
23284800

24343200.0
Mult. for 30 in., as per table, 6.944

97372800
97372800
219088800
146059200

169039180.800 dividend.

Doublings.
6 × 6 × 8 × 2 × 36 = 20736 divisor.

169039180.8 divided by 20736 = 8152 grains, or 18 oz., 11 dwt., 13 grains, weight of yarn produced from 20 oz. of cotton.

	oz.	dwts.	grs.
Weight of cotton fed on feed cloth at lap machine,	20 ..	0 ..	0
Weight of yarn produced, ...	18 ..	11 ..	13
Loss sustained in working, ...	1 ..	6 ..	16.5

Suppose there be a 48 teeth wheel working into a 36 teeth wheel, and finding them of a finer pitch than they should be; what wheels will work in the same place to produce the same speed with the same diameters of wheels?

RULE.—Reduce the wheels to their lowest terms, by dividing them by any number that will divide the number of teeth in the wheels without a remainder; then multiply the lowest terms of the wheels by any one number that will produce the number of teeth required.

Thus,

```
            12)48                    12)36
               —                        —
  Lowest term, 4                         3 lowest term.

   Lowest term, 4                    3 lowest number.
                2                    2
                —                    —
        Wheel, 8  teeth, and  wheel  6 teeth.

   Lowest term, 4                    3 lowest term.
                3                    3
                —                    —
        Wheel, 12  teeth, and wheel  9 teeth.

   Lowest term, 4                    3 lowest term.
                4                    4
                —                    —
        Wheel, 16 teeth, and wheel, 12 teeth.

  Lowest term, 4                    3 lowest term.
               5                    5
               —                    —
      Wheel, 20 teeth, and wheel, 15 teeth.

  Lowest term, 4                    3 lowest term.
               6                    6
               —                    —
      Wheel, 24 teeth, and wheel, 18 teeth.

  Lowest term, 4                    3 lowest term.
               9                    9
               —                    —
      Wheel, 36 teeth, and wheel, 27 teeth.
```

N.B.—The same system will answer, either for increasing or decreasing the number of teeth in wheels.

Any of the above wheels working together will produce the same speed.

JUDKINS' AMERICAN HEALDS, OR PATENT HEDDLES.

PLATE I.

THE machine shown in the drawing is so constructed as to double and twist the yarn from single of itself, and at the same time, at certain points, is converted into a braiding or platting machine, by which the eye or loop of the heddle is formed, without knots of any description.

The advantages of this machine are many. A set of healds is produced by it at a much less cost than by any other method, and without a single knot at any point, the whole being one continuous twine or cord.

By the drawing is also shown a set of healds made by this machine, with the eye or loop as described, which is coated, lined, or covered with a metallic substance, suitable for the purpose.

One set of patent healds will last fifteen of any other kind, and a greater number of yards of cloth, heavier and more perfect, can be produced through it, in a given time, in consequence of less friction upon the warp.

MASON'S SELF-ACTING MULE.

PLATES II. III. IV. V.

Of this machine we give the inventor's specification complete:

The schedule referred to in the letters patent and making part of the same.

To all to whom these presents shall come—Be it known, that I, William Mason, of Taunton, in the County of Bristol and State of Massachusetts, have invented a new and useful self-acting mule for spinning cotton and other fibrous substances, and that the following is a full, clear and exact description of the principle or character which distinguishes it from all other things before known, and of the manner of making, constructing and using the same, reference being had to the accompanying drawings, making part of this specification, in which Fig. 1 is an elevation of the head of the mule next the carriage—Fig. 2 an elevation of the opposite side—Fig. 3 a plan—Fig. 4 a back elevation—Fig. 5 a longitudinal vertical section taken at the line (XX) of Fig. 3, looking in the direction of the arrow—Fig. 6 a front elevation—Fig. 7 a section of, and through the friction clutch—Fig. 8 separate view of the scroll or volute cam—and Fig. 9 a vertical cross section of the head taken just in front of the shipper lever. The same letters indicate like parts in all the figures.

The motions of the mule may be divided into three series, which are subdivided in the action of the apparatus. The first series consists of the drawing out of the carriage, the revolving of the draw-rollers and the whirling of the spindles, by means of which series of motions the rovings are drawn out and the threads spun and twirled. The second series consists of backing off, as it is termed, that is, turning the spindles the reverse direction, to uncoil the threads from the points of the spindles to the cops and turning down or depressing the front faller, at the same time to place all the parts in a proper condition for the third series of motions, which consists of putting or running in the carriage, winding on the yarn or threads by giving a varying motion to the spindles corresponding to the form and size of the cops, and operating the faller to give the proper shape to the cops.

The first series of motions is regular. The carriage is drawn out by a regular motion, effected by a train of wheels from the driving pulley to a line shaft, which carries endless chains connected with the carriage at different parts of its length to insure steadiness of motion. During this the draw-rollers are rotated, to give out the staple as it is spun by another train of wheels deriving motion from the same source as the preceding, and in a manner substantially similar to other mules. And at the same time the spindles are whirled or rotated by a band receiving motion from a pulley on the shaft of the driving pulley as in other mules. This completes the first series of motions, in which I claim nothing new.

At the end of the first series of motions, the threads that have been spun are coiled on the spindles from the cops to their points —it is therefore necessary to uncoil them (called "backing off") preparatory to winding on, and at the same time to depress the front faller to place it in a proper position for winding on. The second series of motions effects these purposes, and the various parts of the mechanism are put in a proper condition to effect this by the momentum of the moving parts at the end of the first series of motions. This constitutes the first part of my invention. As the carriage approaches the end of the out motion, the driving belt is shifted from the first driving pulley to a loose pulley by the side of it, to permit the momentum of the moving parts to complete the movements, and so soon as these are accomplished a balance weight is carried beyond the vertical line and falls over, which shifts the belt from the loose pulley to a second fast pulley on the same shaft with the others, at the same time the trains of wheels that operate the carriage and the draw-rollers are liberated by the shifting of a clutch, and at the same time a friction clutch is brought into action, thereby connecting the band that drives the spindles with a sliding rack (called the "top-sliding rack") which, in consequence of this connection, is carried by the momentum of the spindles sufficiently far in one direction to give by its return the required motion to the spindles in the reverse direction to uncoil the threads from the upper parts of the spindles. Whilst the rack is thus moved, the second fast pulley sets in motion, by a train of wheels, a crank pin that works in a slot in a connecting rod, and this crank pin when set in motion is a little below a line passing through the connecting rod and the axis of motion, so that the crank pin moves a short distance before it begins to move the connecting rod—this period of time is sufficient to permit the momentum of the spindles (as above stated) to draw the sliding rack to the distance required to be in a condition, by its return movement, to give the "backing-off" motion to the spindles. The crank pin then in making a semi-revolution carries the connecting rod with it, and this being in connection with the lever of a rock shaft, provided with a toothed pulley, around which passes a chain attached to the end of the sliding rack, draws it (the rack) for a short distance in a reverse direction, and thus causes it to give the backing-off motion to the spindles, to uncoil the threads, at the same time depressing the front faller to bring the threads in a proper position for winding on, this latter being effected by having one end of the shaper or coping rail jointed to a lever on the rock shaft above-mentioned. The chain attached to the rack and which communicates motion to it, is kept tight by being passed over a pulley and having a weight suspended to it.

When the top-sliding rack is carried forward by the momentum of the spindles at the end of the first series of motions, it is gradually arrested, and with it the spindles, by means of a spring brake of a peculiar construction, viz.:—On the rock shaft there is a bent lever, to one end of which is connected a helical spring also attached to an arm jointed to the other end of the bent lever: and by the side of and attached to, the toothed wheel, around which passes the chain on the end of the sliding rack, and which turns freely on the rock shaft, there is a ratchet wheel and by the side of it a cam plate provided with a hand or catch, by means of which the ratchet and toothed wheels are carried around, when the cam plate is carried around by the action of the spring brake on the cam form of its periphery. And when this has been carried far enough around, the catch is liberated to permit the return of the parts by means of an arm or lever jointed to one end of the bent lever which is made to lift the catch from the teeth of the ratchet wheel. As the cops increase in diameter, it is evident that the backing-off motion must be diminished, and this is effected by making the connecting rod above-mentioned in two parts, the first connected by one end (as above stated) with the crank pin which actuates it and which works in a slot to give motion to the rod in one direction only (the crank being then at liberty to turn without imparting any motion longitudinally to the rod), the other end being jointed to a curved arm that vibrates on a stud pin, and the other part of the connecting rod is jointed to the arm of the rock shaft and to a slide that works in a curved groove in the vibrating arm, so that as this slide is moved from or towards the axis of motion of the arm, the rock shaft will be vibrated more or less and this slide is moved in or out by being in connection with the mechanism that operates the motions of the coping rail, and which will therefore be described under the third series. At the end of the backing-off motion, the vibrating arm of the connecting rod is hooked and held by a catch until the carriage is run up, and then liberated to permit the parts to resume their appropriate positions preparatory to a repetition of the operation.

At the end of the second series of motions the third series of motions commences, and these constitute the second part of my invention. The carriage is run in by a crank motion, which has the effect to gradually start it from a state of rest, and accelerate its motion to the middle of its course, and then gradually diminish its motion until it is brought to a state of rest—thus avoiding all tendency to break the threads consequent upon all sudden motions. This is effected in the following manner, viz.: When the shipping lever is operated at the end of the first series of motion, a clutch on a shaft carried by the second fast pulley is shifted, and on this clutch has but one tooth, the shaft is thereby permitted to make part of a revolution, during which the second series of operations takes place before it (the clutch) begins to act, and then it communicates motion to a large cog-wheel provided with a crank pin, that actuates a connecting rod jointed to a rack (below the top-sliding rack above described), the teeth of which take into the teeth of a pinion on the shaft of one of the train of wheels that communicate motion to the carriage, thereby imparting the desired movement. The winding on of the yarn during the running in of the carriage is effected by the top sliding rack, which for the purpose is carried by the rack just described, by means of such connections as admit of modifying the motions of the top-sliding rack which drives the spindles in winding on. Motion is communicated from the bottom to the top rack in the following manner:—On the end of the lower rack and by the side of it, there is a stud pin on which turns a scroll cam, and to that part of its periphery which is nearest the axis is attached one end of a chain, which passes from thence around a roller that turns on a stud pin at the side of the lower rack, and is then carried back and attached by a short arm to the top-sliding rack, so that when the lower rack slides the top rack will move with it, provided the scroll can remain immovable on its axis, but as the motion of the top rack during each operation must have a motion accelerated relatively to that of the lower rack, to increase the rotation of the spindles, as the threads are wound on a gradually diminishing diameter of the conical form of the cops—this is effected by causing the scroll cam to turn on its axis during the motion of the rack, by having a wheel attached to and turning with it, to the periphery of which is attached one end of a chain, that passes around it, and is attached by the other end to another part of the machine, so that if this part of the attachment remains fixed, a regular accelerated motion will be given to the top rack, relatively to the motion of the lower rack, and necessarily the spindles will have their rotation accelerated relatively to the motion of the carriage. These relative motions of the two racks, as described, are such as are required after the base of the cops has been formed, for then the threads are wound regularly on a cone: but in forming the base of the cops the first winding is on the naked spindles, at which time the motion of the spindles should correspond with that of the carriage, and from the commencement until the base is formed, the accelerated motion should be gradually brought into play, to give the conical form to the cops. This is effected by having the chain that winds on the wheel that turns with the scroll cam, attached to a slide that works on a screw in a vibrating arm, the outer end of which is jointed to another arm of equal length, that turns on the end of the stud, on which the scroll cam and wheel turn, so that when the slide is at the lower end of the arm, the two arms being of equal length, the motion of the wheel with the rack will not cause it to wind up the chain, but, as the slide is drawn up towards the axis of vibration of the arm, one end of the chain will necessarily move through a less space than the other, and thus cause the wheel, with the scroll cam attached thereto, to turn on its axis, and thus to vary the motion of the top rack, and thereby adapt the motion of the spindles to the varying diameter of the base of the cops. The screw in the vibrating arm that carries the slide, is in connection by means of appropriate cog-wheels with a horizontal ratchet wheel, which is free to move when the arm vibrates in one direction, but held by the hand or catch when the arm vibrates in the reverse direction, for the purpose of turning the screw to move the slide: and this hand or catch is governed by an apparatus called a butterfly, which is acted on by an arm from the counter-faller, when the tension of the thread is too great, and thus throws the hand into the teeth of the wheel, that the vibration of the arm shall operate the slide—the hand or catch being disengaged at each running out of the carriage. The last of the third series of motions is the operation of the coping rail for operating the faller, which being essentially similar to others, needs no special notice here.

At the end of the running in motion of the carriage, a pin on an arm projecting from the shaft of the crank that operates, the under rack liberates the catch that holds the connecting-rod, by which the backing-off motion is effected, and so soon as it is liberated, the weight of the machinery attached draws it back —and to prevent any sudden jar by this operation, the crank pin which operates the connecting rod in one direction, is so governed in its revolutions as to be nearly a semi-revolution from its point of departure, at the commencement of the backing-off operation, so that the force required for carrying it back to this position is sufficient to ease off the motion of the returning parts. This crank pin is held in the position just indicated by a brake within the second fast pulley, and this brake is connected by a joint link and lever with the arm of the connecting-rod of the backing off apparatus, which, when drawn back, forces the brake in contact with the pulley, and arrests the train of wheels and this crank pin in their appropriate place.

When finishing the caps it is important to wind the threads on tight at the point, particularly as the upper ends of the spindles are tapering. This is effected by forming the connection between the chain and the end of the top sliding rack by means of a vibrating frame, from which projects another arm that has a chain jointed to it, extending to and winding on an arbor, which arbor has a ratchet-wheel on it, which is carried a part of a revolution at each operation of the mule by a hand on the arm of the connecting rod of the backing-off motion; and this auxiliary chain is of such length that it continues to be wound upon the arbor without affecting the operations of any part of the machinery until the caps are nearly completed, and then it becomes so short as to be brought in contact with a permanent arm towards the end of the winding-on operation, and when thus brought in contact with this arm it suddenly shortens the chain that forms the connection between the two racks, and necessarily increases the rotation of the spindles, which, as a necessary consequence, draws the threads tighter on the spindles.

In the accompanying drawings (A^3) represents a frame properly adapted to the operative parts of what constitutes the head of the mule, the carriage not being represented, as it is in every particular similar to other mules. (A A^1 A^{11}) are three pulleys of equal diameter and placed side by side on the main shaft (B).

The one (A) is the first fast pulley attached to, and turning with the shaft (B). (A^{1}) is the second fast pulley, carrying a pinion (D), and turning freely on the shaft (B), and (A^{11}) is a loose pulley placed between the other two and turning freely on the shaft. A driving belt from some first mover passes over these pulleys and is guided to either of them by a shipper lever (C) that vibrates on a steel pin (W), and connected with a weighted balance lever (C^{3}), by which it is operated when the belt is to be shipped from one to another of these pulleys. [At the commencement of the first series of operations, the belt runs on the first fast pulley (A^{1}), to give the first series of motions. The pinion (J) on the shaft (B) communicates a positive and regular motion to the shaft (G), (which is in connection with the draw rollers in the usual manner), by means of the first train of wheels (K, L, J), and from the shaft (G) by the second train of wheels (N, O, P, R, S, X), to the line shaft (Y) that drives the carriage by means of endless chains (Z) connected with the carriage by one of the links (Z^{3}).

There is but one of these chains represented in the drawings, and the shaft is shown as broken off, as the connections with the carriage present nothing new, and therefore need not be represented. And at the same time the spindles are rotated or whirled by the usual band (T^{1}), driven by the pulley (O^{1}), on the same pulley shaft (B). This completes the first series of motions, viz: drawing out the carriage, rotating the draw rollers, and whirling the spindles, to draw out, spin and twist the threads.

Towards the end of the running out motion of the carriage, the belt is shipped from the first fast pulley (A) to the loose pulley (A^{11}) which removes the driving power from these motions. This shifting of the belt is effected in the following manner, viz: the weighted balance lever (C^{3}) is jointed to the shipper lever at (2), and above the stud pin (3), on which it vibrates, its upper end being weighted to enable it to fall over by gravity, after the weight has been carried a little beyond the vertical line. The lower end of this balance lever is T formed, and one of its short arms is jointed by a link (4), with a short lever (5) that turns on a stud pin (6), and this lever is also connected by a link (*d*) with another lever (*h*) that turns on a stud pin (*c*), and this last lever is depressed when the belt is to be slipped by means of a pin (*a*) in a vibrating arm (L^{1}) on the shaft (K^{1}) of the wheel that carries the connecting rod by which the carriage is run in. The balance lever is by this means carried a little beyond the vertical line, and then carried entirely over by the weight of the lever (C^{3}). On this same shaft (K^{1}), and on the opposite side of the frame there is another arm (M^1) provided with a pin (*g*), which at the same time depresses another lever (N^1), converted by means of a jointed rod (*h*) with an elbow lever (7) that operates a clutch (M) on the shaft (G) by means of which the cog-wheel (I) is clutched to its shaft, or unclutched, so that when the driving belt is removed from the fast pulley (A) to disconnect the parts that give the first series of motions to the wheel (I) is unclutched, which liberates the draw rollers, and the second train of wheels that communicate motion to the carriage from the parts that drive the spindles, so that they (the spindles) are free to continue to move by their momentum independent of the draw rollers and carriage. The clutch (M) is held open until the belt is again carried to the first fast pulley at the end of the third series of motions by a pin (j^1) in one arm of the balance lever (C^3) which bears against one side of the arm of the clutch lever (7), for the lever (N^1) that operates the clutch lever is provided with a helical spring (*i*) attached to it and the frame, for the purpose of forcing the clutch in the moment that the pin (*j*) of the balance lever (C^3) liberates the clutch lever (7). The parts being thus situated, and the driving belt in the loose pulley, the momentum of the spindles will cause them to continue to turn for some time, and thus commences the second series of motions.

The band (T^1) that carries the spindles, and which, as stated above, passes around and is carried by the pulley (O^1) on the main shaft (B), passes around a guide pulley (R^1) at one end of the frame, and another (S^1) at the other end, and also around another pulley (P^1) that runs freely on a shaft (Q^1), except when clutched to it, which is done at the time the driving belt is slipped from the first fast pulley (A). This pulley (P^1), called the "friction clutch pulley," is a hollow cone lined with leather, into which is received a conical friction clutch (P^{11}) attached to the end of the shaft (Q^1), which slides endwise in its bearings, and in the friction pulley, which is prevented from sliding endwise with the shaft by a collar (8); so that, when this shaft (Q^1) is moved in one direction, the pulley (P^1) is clutched to it by the friction of the conical surfaces, and when moved in the reverse direction, it is unclutched, and turns freely on the shaft. This clutching and unclutching is effected by an arm (Z^2 Fig. 5), on the spindle (U^1) of the shipper lever (C), which embraces a collar on the shaft (Q^1), so that when the shipper (C) shifts the belt from the first fast pulley (A), it at the same time gives the requisite movement to clutch the friction clutch that connects the spindles with the shaft (Q^1), which will be carried by their momentum, and as this shaft is connected by the train of wheels (X^1, Y^1, Z^1 and C^{11}), with a horizontally sliding rack (W^1), it (the rack) will be carried for a short distance in the direction of the arrow thereon. See Fig. 5. When the shipper transfers the belt from the first fast to the loose pulley, a clutch (D^2) Fig. 9, on the shaft (D^1) is shifted by the forked lever (*f*), which turns on the stud pin (10), and is operated by a spur (11) on the balance lever (C^3), which bears on the end of a volute spring (12) attached to the lever (*f*), the tension of which forces the sliding part of the clutch against the permanent part, which, having but one cog, causes it to clutch, when by the rotation of the shaft the parts coincide. The sliding part of the clutch is feathered to the shaft (D^1), which is carried by a train of wheels (C^1 B^1), and pinion (D), on the second fast pulley (A^1), driven by the driving belt, when it is shifted by the shipper, which carries it from the first fast pulley (A) to the loose pulley (A^{11}), and then to this, the time required for this transfer of the belt by the motion of the shipper being sufficient for the preparatory movements.

So far, it has been shown, that the second fast pulley carries the shaft (D^1) of the clutch (D^2) a part of a revolution, before clutching the pinion (E^1) which gears into the wheel (F^1) that runs the carriage in (as will be hereinafter described), this period of time being required to enable the momentum of the spindles to run back the rack (W^1) preparatory to the backing-off motion.

As the rack (W^1) is carried by the momentum of the spindles in the direction of the arrow, preparatory to the backing-off motion, it is necessary gradually to arrest this motion, which is effected by a friction-spring brake, constructed and connected with the rack in the following manner. To the end of the rack is attached a chain (*m*), which passes over a pulley (*o*), and then around a spur-wheel (*p*), attached to a ratchet-wheel (H^2), and with it turning freely on a rock-shaft (*n*), and then it passes over another loose pulley (D^3), and to the end of it is suspended a tension weight (E^2), which takes up the slack of the chain. On the said rock-shaft (*n*), and by the side of the ratchet-wheel, there is a cam plate (*t*), that also turns freely on the shaft, and which is carried in one direction by the ratchet-wheel, when the catch or hand (*v*), which is jointed to the cam-plate, takes into the teeth of the ratchet, the two turning independently of each other in the reverse direction, or in the same direction, when the catch or hand is lifted out of the teeth. When the rack is drawn by the momentum of the spindles in the direction of the arrow, the chain (*m*) attached thereto turns the spurs and ratchet-wheel in the direction of the arrow, and the cam-plate is also turned in the same direction, by the catch or hand (*v*); this motion is gradually arrested by the enlarged or scroll-form of the cam-plate, which forces out a friction arm (b^1), one end of which is jointed at (a^1), to one arm of a lever (F^3) attached to the rock-shaft (*n*), the other arm of this lever being connected with the friction arm (l^1) by a helical spring (S), it will therefore be perceived, that as the friction-arm is forced out by the cam-plate, the tension of the spring increases the friction of the brake on the periphery of the cam-plate, which gradually arrests the motion of all the parts in connection with the rack (W^1), and of necessity the spindles. When these parts are arrested, the rock-shaft (*n*) is turned in the opposite direction, and carries with it the cam-plate, ratchet-wheel, and spur-wheel by the pressure of the brake, and of necessity reverses the motion of the rack and spindles to uncoil the threads from the spindles. At the end of this motion, the catch (*v*) of the cam-plate is liberated from the ratchet-wheel (H^2) by a spur (*x*) of a lever (*y*) jointed at (14), to the arm (F^3) of the rock-shaft (*n*), the spur being forced on to the back end of the catch by the rotation of the rock-shaft, the lever (*y*) having a slot in it which turns and slides upon a permanent rod (*z*). This reversed motion of the rock-shaft (*n*) is effected by a crank motion in the following manner, viz.: The pinion (D) on the second fast pulley (A^1) communicates motion by the train of wheels (B^1 C^1 and R^2) to the wheel (Q^2) in the direction of the arrow, and this wheel carries a crank pin (h^1), that works in a slot (h^2) of a connecting rod (O^2), jointed to a curved arm (K^2) that vibrates on a fixed stud-pin (15), and this arm has a slot in it which works a slide (e^1), for the purpose of graduating the backing off motion, and to this slide is jointed another connecting rod (J^2), the other end of which is jointed to the arm (I^2) of the rock-shaft (*n*). At the time that the driving belt is shifted to the second fast pulley (A^1), which takes place while the momentum of the spindles prepares the parts for the backing-off motion, the crank pin (h^1) is at (h^3), a little above a line passing from the centre of the wheel to the junction of the connecting rod (O^2) and the arm (K^2), so that the crank pin on this wheel can move around to the position represented in Fig. 2, before it begins to draw the connecting rod, to give time for completing the preparation of the parts for backing off. In rotating from (h^1) to (h^4), the crank pin carries the connecting rod the required distance to give the required backing-off motion to the spindles to uncoil the threads, and at the same time depresses the faller to guide the threads to the cops, preparatory to winding on by means of the coping rail or former (G^2), one end of which is connected by a slot with a wrist (*q*) on an arm (F^2) of the rock-shaft (*n*), the elevation of which by the backing-off motion of the rock-shaft (*n*) depresses the faller. So soon as the connecting rod (o^2) has been carried to the point (h^4) by the crank pin, which is the extent of the backing-off motion, the catch lever (U^2) takes hold of the pin (13) on the arm (K^2), and there holds all the parts of the backing-off operation until released towards the end of the running-in motion of the carriage, the liberation of the parts being then effected by means of a pin (l^1) on the arm (L^1) on the shaft (K^1) of the wheel (F^1), which runs in the carriage. So long as the backing-off apparatus is held by the catch lever (U^2), the crank pin (h^1) can revolve freely, the slot in the connecting rod (O^2) admitting of this. When the backing-off apparatus is liberated, it falls back to the position indicated in the drawings by the weight of the coping rail and the other parts attached to the rock-shaft; and to prevent jar, this return motion of the parts is eased off by the connecting rod (O^2), coming against the crank pin (h^1) at the point (h^3), the power required to turn this train of wheels in the reverse direction being sufficient to ease off and gradually arrest the moving parts without jar. This return motion of the backing-off apparatus at the same time arrests the second fast pulley (A^1) and the train of wheels in connection with it, by means of a brake (j^1) connected by the arm (T^2), and link (S^2) with the arm (K^2) of the backing-off apparatus, and the train of wheels and the connection of the brake are so regulated as to stop the crank pin (h^1) at the point (h^3), where it is required to be when the second series of motions is commenced. The link (S^2), and the connecting rod (J^2), are provided with adjusting screws for the proper adjustment of all these parts.

As the backing-off motion must be gradually decreased as the cop is formed and increased in length, the vibrating motion of the rock-shaft is gradually shortened by means of the slide (e^1) in the arm (K^2) to which the connecting rod (J^2) is jointed.

For this purpose, the slide is attached to a chain (d^1), which passes over the upper end of the arm, and is gradually wound upon the arbor (e^{11}) of a cog-wheel (L^2) that gears into a pinion (f^1) of a ratchet-wheel (N^2), which receives motion from the vibration of the arm (K^2) of the backing-off apparatus, by a hand or catch (M^2) jointed thereto at (g^1). It will be evident that, as the slide is drawn up by the chain towards the axis of motion of the arm (K^2), the motion of the connecting-rod (J^2) will be diminished, and with it the motion of the backing-off apparatus.

This completes the second series of motions, and the mule is then in a condition to commence the third series.

When the clutch (D^2) at the end of the backing-off motion clutches the pinion (E^1), it begins to turn, which communicates motion to the cog-wheel (F^1) on the shaft (K^1); and to the periphery of this wheel at (G^1), is jointed a connecting-rod (H^1), the other end of which, at (I^1), is jointed to a horizontal sliding-rack (V) that runs on ways (W), that carries, by means of the pinion (U), the train of wheels that communicate motion to the carriage. The wheel (F^1) is carried but part of a revolution (nearly one-half) in one direction by its connection with the second driving-pulley (A^1), when the clutch (D^2) is closed, which gives, by the crank-motion in consequence of the connection above pointed out, the peculiar running-in motion to the carriage, as pointed out in the description of the general characteristics of this invention; and, as the carriage approaches the end of its running-in motion, the pinion (E^1) is unclutched by the reversed action of the shipper-lever (C^3), this reversed motion of the shipper and its appendages being effected by the pin (*e*) on the arm (L^1) of the shaft (K^1) of the wheel (F^1), this pin (*e*) being on the side of the shaft (K^1) opposite to the pin (*a*) which first ships it. The unclutching of the pinion (E^1) leaves the wheel (F^1) free to be turned back by the reversed motion of the rack (V) by the train of wheels which run out the carriage in the first series of motions.

As the carriage is run in by the means just described, the spindles must be turned to wind up the threads which have been spun during the first series of motions, and this is effected by means of the top sliding-rack (W^1), by which the backing-off motion is given, and which is placed on top of the main rack (V). The connection of this rack (W^1) with the spindles, by means of the friction-clutch, having been described, it is only necessary to describe the manner in which the winding-on motion is communicated to it by the main rack (V), and the manner in which this motion is varied and regulated to correspond with the varying size of the cops as they are formed. To the upper rack (W^1), and near one end of it, is jointed a lever (m^1), to the short arm of which is attached a chain (l^1), which thence passes around a pulley (k^1) that turns on a stud-pin projecting from the side of the main rack (V), the other end of the said chain being attached to the smallest diameter of a scroll-cam (n^1) connected with the end of the main rack (V). From this arrangement it will be obvious that if the cam (*n*) be prevented from turning on its axis, the motion of the main rack (V) will carry the top rack in the same direction and with the same varying velocity, which would give to the spindle a winding-on motion corresponding with the running-in motion of the carriage, such as would be required if the cops were to be formed cylindrical and did not vary in diameter; but such is not the case, as clearly pointed out in the general description. To give the varying motion required and fully pointed out above, the scroll-cam (n^1) is attached to and turns with a wheel (v) on the stud-pin (I^1) on the main rack (V), and to this wheel, at (w), is attached a chain (x^1), which, after passing around a portion of the circumference thereof, is attached by a link (y^1) to a slide (z^{11}) that travels on a screw (a^{11}) that turns in the arm (V^2) of a rack-frame (V^3), the lower end of the said arm being jointed to another arm of equal length (W^2) that vibrates on the stud-pin (I^1) on which turn the wheel (v^1) and the cam (n^1), so that when the slide (z^{11}) is at the lower end of the arm (V^2), that end of the chain (x^1) which is attached to the slide, during the movements of the main rack, will not communicate motion to the wheel (v^1) and cam (n^1); hence the motions of the two racks (V) and (W^1), will correspond and give to the spindles the motion required for winding the threads on the naked spindles, and, as the base of the cops is increased in diameter, the slede (z^{11}) is drawn up towards the axis of motion of the arm (V^2) to decrease the motion of that end of the chain (x^1) attached to it, which will cause the wheel and cam to turn on their axis, and thus give out the chain (l^1), thereby giving to the top rack (W^1), and, consequently, to the spindles, a gradually reduced motion relatively to the main rack to correspond with the increased diameter of the base of the cops. The motion required is given to the slide (z^{11}) by the vibrations of the rock-frame (V^3), the screw (a^{11}) that operates the slide being connected by a train of cog-wheels (b^{11}, e^{11}, g^{11}, h^{11}, i^{11}, j^{11}), with a horizontal ratchet-wheel (l^{11}), which turns freely by the rocking motion of the frame (V^3) in one direction, and which, therefore, does not turn the screw but which is prevented from turning in the opposite direction (during the running-in motion of the carriage) by a catch or pawl (r^{11}) to turn the said screw.

Whenever the tension of the threads in winding on is too great, it bears down the counter-faller (not represented in the drawings), the arm of which in the running-in motion of the carriage strikes an arm (S^{11}) of what is termed a butterfly, that turns on a stud pin (q^{11}), on which the catch or hand (r^{11})

of the ratchet (l^2) also turns, and with which it is connected by a spring (w^2), (see Fig. 1), and throws it into the teeth of the ratchet-wheel—the wheel being thus held, the farther vibration of the rock-frame turns the screw, and carries up the slide to reduce the motion of the spindle, and on the return motion of the carriage, the hand or catch (r^{11}) is thrown out of the teeth of the ratchet-wheel by the arm of the counter-faller, which then comes in contact with another arm (t^2) of the butterfly, the end of which extends lower down than the arm (S^2), and low enough to be struck by the arm of the counter-faller, when it is not under the action of the tension of the threads. The catch or hand then remains out, until the tension of the threads again requires the motion of the spindle to be reduced. The butterfly is connected with a hand-catch lever (m^2) that turns on a stud-pin (m^2), by which the attendant can throw the butterfly in and out of play. So soon as the base of the cop has been formed, the scroll form of the cam (m^1) gives the regular varying motions to the spindles to wind the cone of the cops, as fully pointed out in the general description.

It has been stated that in finishing the cops, the threads are wound on harder at the point of the cops—this is effected in the following manner. On the shaft (e^{11}) which regulates the backing-off motion as described above, there is a hub (q^1) from which projects a crank arm (t^1), to the pin (S^1) of which is jointed by a link (r^1), a chain (p^1), the other end of which is jointed by a link (O^1) to the long arm of the lever (m^1), which forms the connection between the top rack (W^1) and the chain (l^1), which forms the connection between the top and main racks. This shaft, as heretofore described, is connected with the ratchet-wheel (N^2) which is operated by the catch or hand (M^2) of the lever (K^2) of the backing-off apparatus, and the chain (p^1) is of such length that it is wound up by the rotation of the shaft, until towards the completion of the cops, at which time it is drawn sufficiently tight to strike against a permanent arm (u^1) towards the end of the winding-in motion, which causes the lever (m^1) to turn on its axis, and by its connection to draw up the chain (l^1), and hence to increase the velocity of the rack (W^{11}), and, therefore, the rotation of the spindles which winds the threads on tighter—this operation gradually increases to the completion of the cops. On this same shaft (e^{11}) is placed the coping arm (y^2), the periphery of which acts on the lever (x^2), to which the coping rail or former (G^2) is jointed at (r) in manner well known to those acquainted with the construction of self-acting mules, and which, therefore, needs not to be described. This completes the whole series of motions, but it will be obvious that when one set of cops has been completed, the parts employed in giving the progressive movements, such as the shaft (e^{11}) that rotates the coping or forming cam (Y^2) winds the chain which carries the slide (e^1) of the backing-off apparatus, and the crank arm (t^1) that winds the chain (p^1) to increase the tension of the threads in finishing the points of the cop, and also the ratchet-wheels (l^1) which governs the motions of the slide (z^{11}) on the arm (V^2), by which the winding-on motion of the spindles is regulated to form the base of the cops, are to be turned back by hand to their original positions by the attendant preparatory to commencing a new set of cops.

I have thus described the general character of the invention, and the manner of constructing and using the same, but before pointing out what I claim as my invention, I wish it to be distinctly understood that I do not limit myself to the precise form and construction of the various parts employed, or to the precise arrangement described, as I consider all mechanical equivalents as within the limits of my invention.

What I claim, therefore, as my invention, and desire to secure by letters patent is—*First*, the disconnecting of the mechanism employed in running out the carriage and turning the draw rollers, from the mechanism which gives the whirling or spinning motion to the spindles, when the driving power is shifted from these the first series of motions, to enable the spindles to continue their motion by inertia, independent of the other motions, by means of the clutch box (or its equivalent) which forms the connection between the three movements constituting the first series of motions, whereby the momentum of the spindles can be employed for preparing the parts for the backing-off motion, substantially as described. *Second.* The method of preparing the parts for the backing-off motion by means of the momentum of the spindles, by connecting them with the backing-off apparatus by means of the friction clutch, or any equivalent therefor, substantially as described. *Third.* The backing-off apparatus consisting of the combination of the top-sliding rack, which communicates motion to the spindles, the rocking shaft with its cam and spring brake and other appendages, and the connecting rod operated by the crank, all substantially as described. *Fourth.* The method of decreasing the backing-off motion to correspond with the increased length of the cops, by means of the slide in the intermediate arm of the connecting rod (between the two sections of the connecting rod), by means of which the rocking motion of the rock-shaft is gradually decreased, substantially as described. *Fifth.* Combining the train of wheels which actuates the backing-off motion of the carriage, by means of a clutch substantially as herein described, which admits of the necessary backing-off motion before the tooth of the clutch starts the carriage, whether this be effected by a clutch or by any other means substantially the same. *Sixth.* Running in the carriage by means of a crank motion which actuates a sliding rack that communicates the desired motion to the carriage, so as to start and arrest it gradually, substantially as described, to avoid any sudden strain or jar upon the threads. *Seventh.* The method of communicating the winding-on motion to the spindles from the main rack, which runs in the carriage by combining the said main rack with the top-sliding rack by means of a chain and scroll cam, or their equivalents, by means of which combination in connection with the form of the cam, the motions of the spindles so correspond with that of the carriage, as to wind the threads on the conical form of the cops as described. *Eighth.* The method of varying the winding-on motion of the spindles to form the base of the cops, by means of the slide and chain which vary the motions of the wheel that is attached to, and which rotates the scroll cam substantially as described, whether the slide be operated by the vibration of the arm on which it slides, or by any other means substantially as herein described. *Ninth.* The method of regulating the motion of the slide that varies the motions of the scroll cam of the winding-on motion, by means of what is termed the butterfly and its appendages, when this is acted upon by the counter-faller, operated by the tension of the threads, substantially as described. And, *Tenth.* The method of winding on the threads tighter at the points of the cops, when finishing them by means of the apparatus, which gives to the top-sliding rack, an increased motion towards the end of the operation, the said apparatus consisting of a chain which is connected with the chain that forms the connection between the main and top racks, and which is gradually wound up, and strikes against an arm towards the end of the operations of the mule, to shorten the connection between the two racks, and thus increase the winding-on motion of spindles as described.

NIAGARA THROSTLE, OR McCULLEY'S SPINNING FRAME.

PLATES VII. VIII.

THIS machine possesses the following advantages *over all other kinds* of Throstle or common Ring Spinning Frames:—

1. A saving of one-half THE POWER consumed by the Spinning Frames now in general use.
2. It occupies one-fifth less space.
3. It is operated with one-third less LABOR compared with its product.
4. It requires but one-half the OIL of other Spinning.
5. All Banding is entirely dispensed with.
6. The REPAIRS are not one-half that of frames running with bands.
7. It is not affected by change of weather; therefore it uses a uniform amount of power.
8. It can be operated at much greater speed and without a corresponding increase of power and wear and tear.
9. It gives a stronger and more uniform motion to the spindle and a more even twist to the thread.
10. It combines superior advantages for Spinning fine WORSTED, with great speed and perfection.
11. It is particularly well adapted for doublers and twisters for thread, and many are now in operation.

There are many minor advantages with this, over *all other* spinning now in use. It does not throw off the oil—it is a much more durable machine, and gets rid of bands with all their expense, annoyances, imperfections and uncertainties. It does not require that attention and skill in the overseer to regulate it, after it is adjusted to give the twist intended; *and when once adjusted, so it will remain and continue to operate.* If required, the Spindles may be driven 10,000 revolutions per minute. Nearly *two-thirds* the power of a Cotton Mill is wanted to drive the spinning, and the great saving in power by this frame reduces the weight and expense of main gearing, shafting, pulleys, and belts correspondingly. It can be readily changed from coarse to fine yarn. Either side of this frame may be operated independently of the other, and stopped at pleasure, without affecting the operation of the other side.

These are believed to be *fair statements* of facts, which the operation of this machine with more than two years practical test fully confirms.

These Spinning frames may be seen in operation, in many sections of the country.

The *novelty* consists in the *mode of driving* the *Spindles, Flyers,* and *Bobbins* by *friction pulleys* instead of bands (the old way), as invented and patented by Francis McCulley, Jr. The lithograph represents a *Ring* Spinning Frame, in which the usual cylinders and bands are dispensed with, and the friction pulleys are introduced. The invention is as applicable to driving *flyers*, and also for *Doublers* and *Twisters*, and *Worsted Frames.* It may be applied to all kinds of throstle spinning, with similar advantages. It is very largely in operation, and with the universal testimony of those using them, that the *motion to the spindle* is *stronger*, more *regular* and *uniform* driven by friction pulleys, than when driven by bands. There is a whirl made fast to the spindle, the underside of which is covered with leather, and rests upon the periphery of the pulley. These leathers will last for many years, and the spindles and bearings wear but very little, having no bands pulling them.

Fig. 4, Plate VIII. is an end elevation, showing the arrangement for the gears and belts for driving the rolls and lifting motion for the rails.

Fig. 1, Plate VII. is a front elevation, showing the rolls, spindles, and an edge view of the friction-disks for driving the spindles. These disks and the whirls running upon them constitute the parts patented by McCulley.

Fig. 3, Plate VIII. is a vertical section of the machine through the centre of one section, showing the roller-stands; the manner of weighing top-rolls by the weights; the bearings for the side-shafts, stands for the spindles, guide-rod for raising top or ring rail.

Fig. 2, Plate VIII. is an end elevation.

Further information may be obtained of the Agents, Miner & Pitman, 171 Milk Street, Boston, Mass., or of Arthur M. Eastman, of Boston, the proprietor of the patent, and who has been chiefly instrumental in bringing this admirable machine to its present state of perfection.

Plate VI.

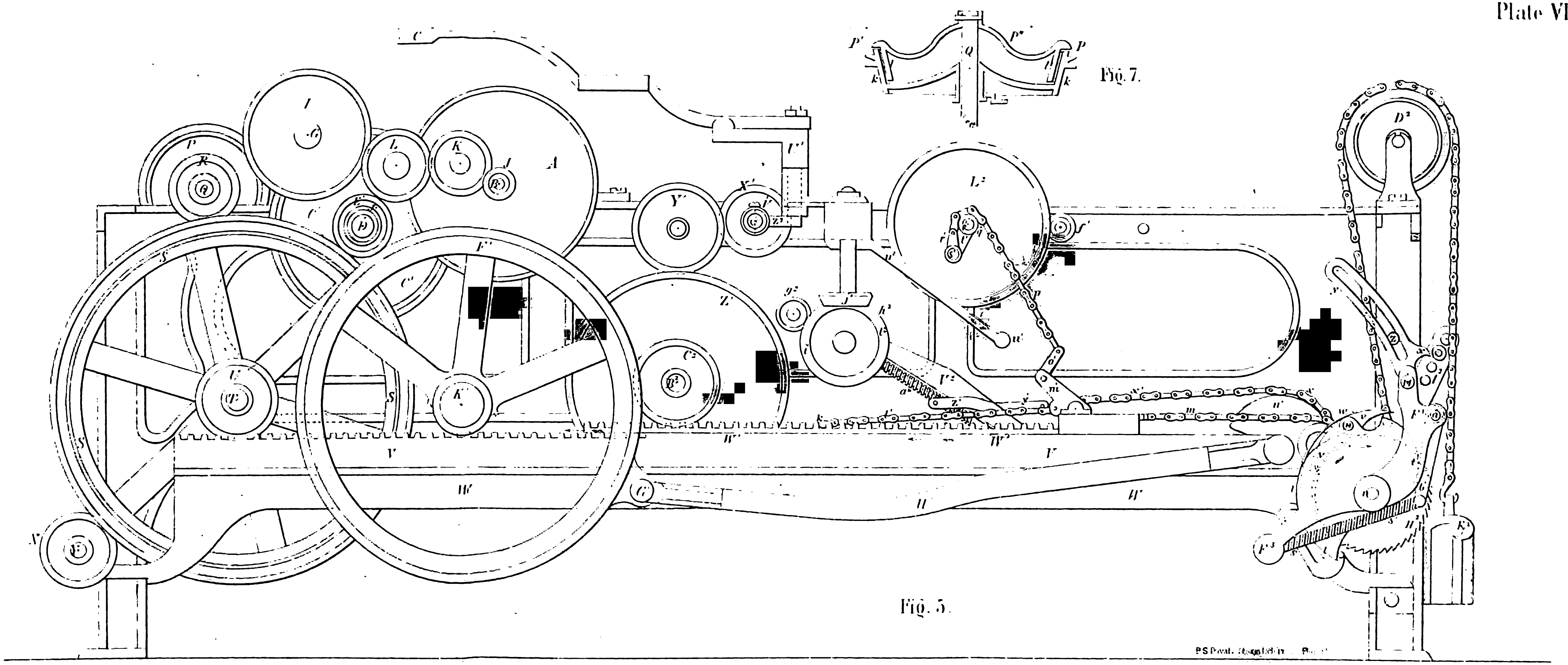
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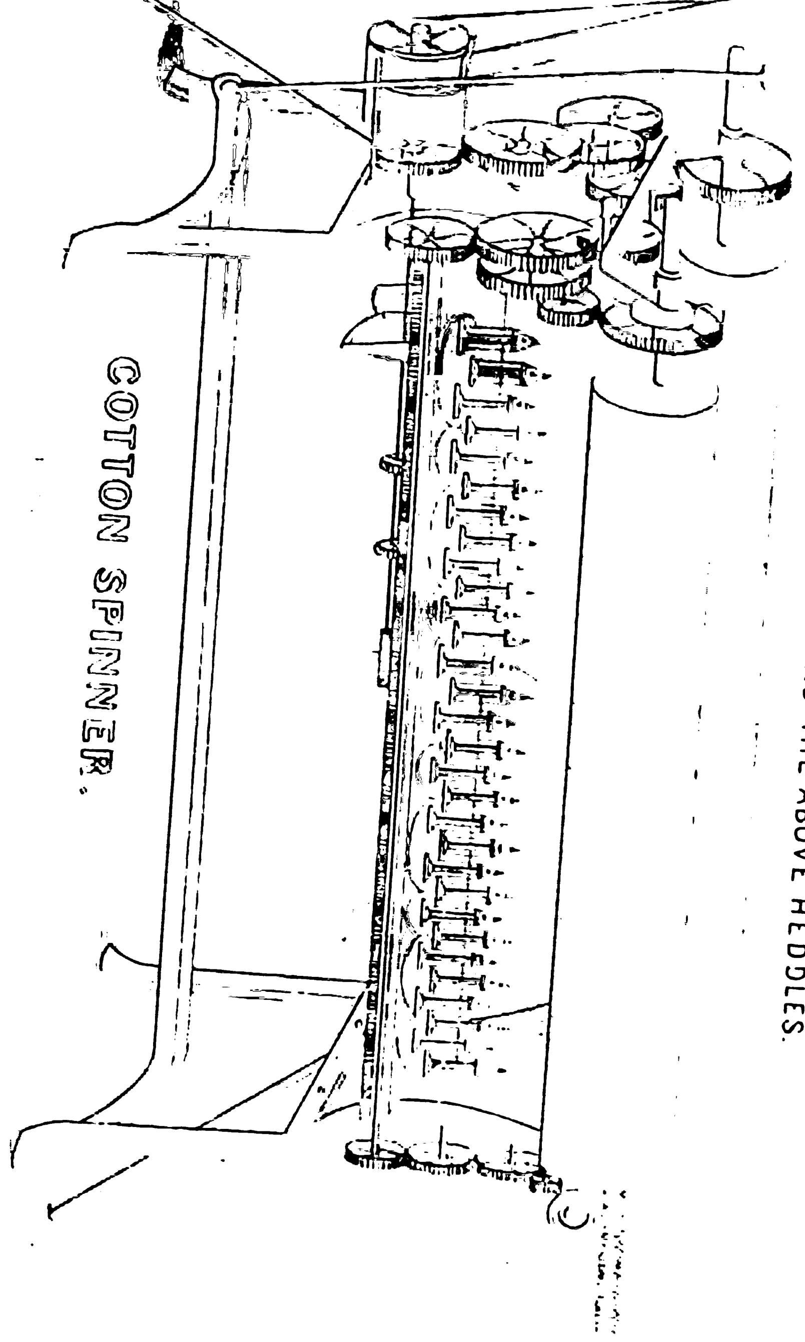
Fig. 7.

Fig. 5.

COTTON SPINNER.

C. T. JUDKINS' PATENT HEALDS OR HEDDLES.

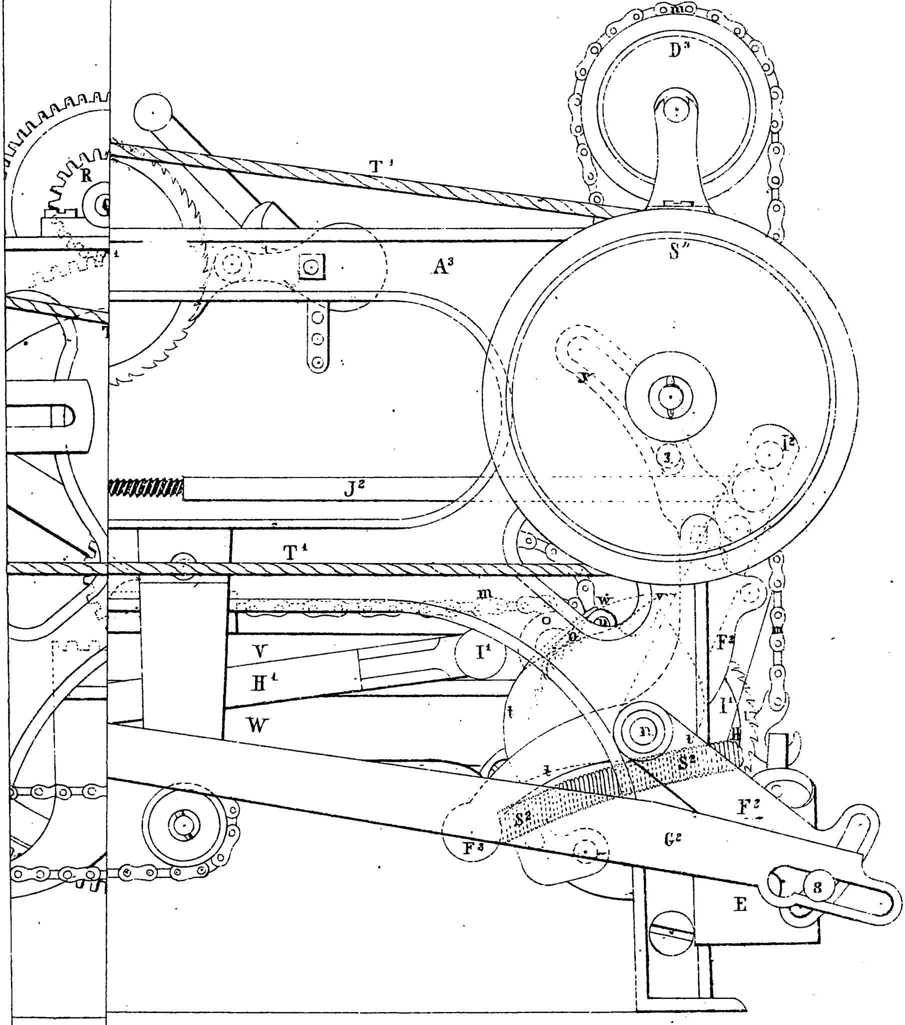
MACHINE FOR MANUFACTURING THE ABOVE HEDDLES.



COTTON SPINNER.

Plate I.

Plate II.



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P. S. Duval's Steam Lith. Press.

MASON'S MULE.

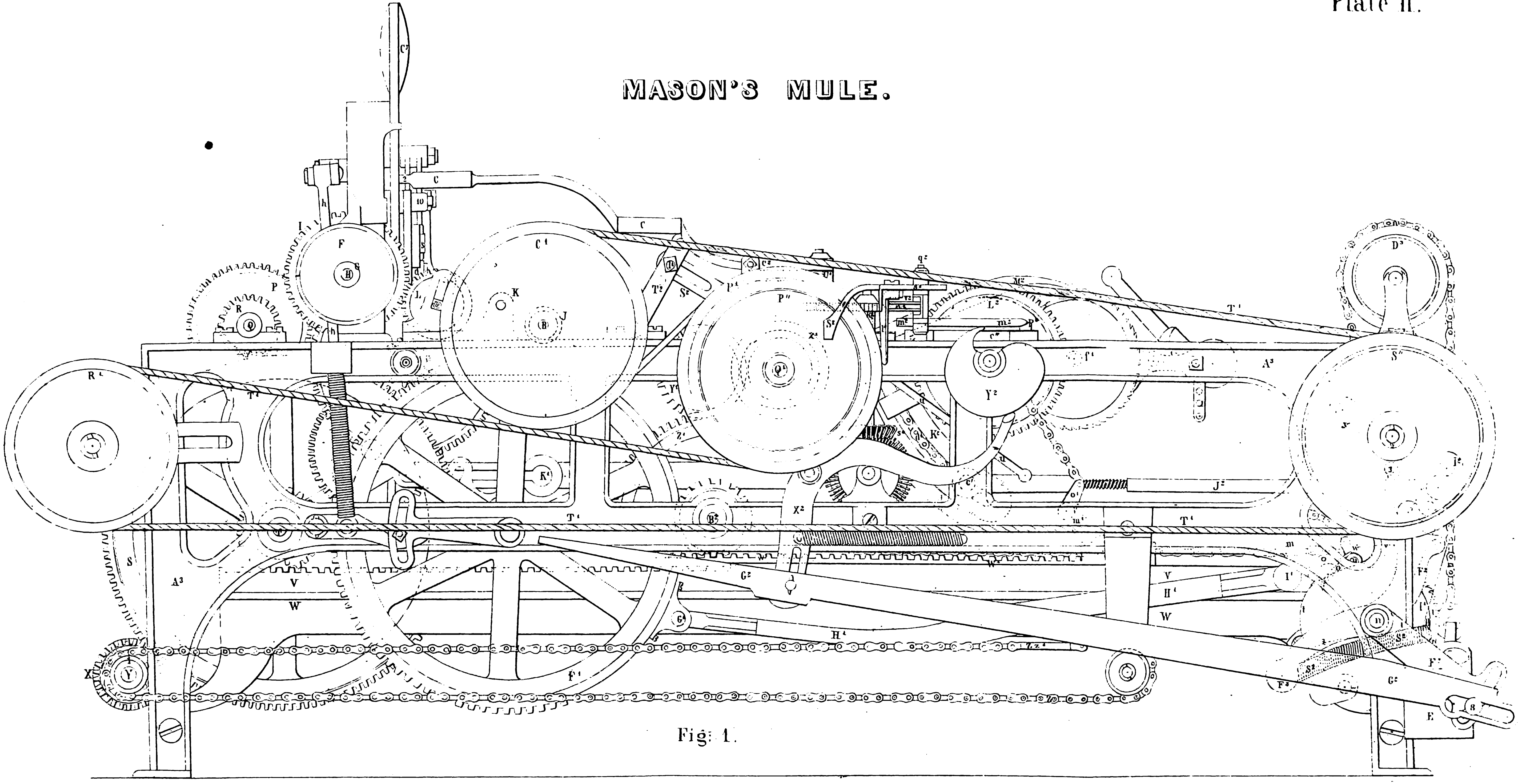
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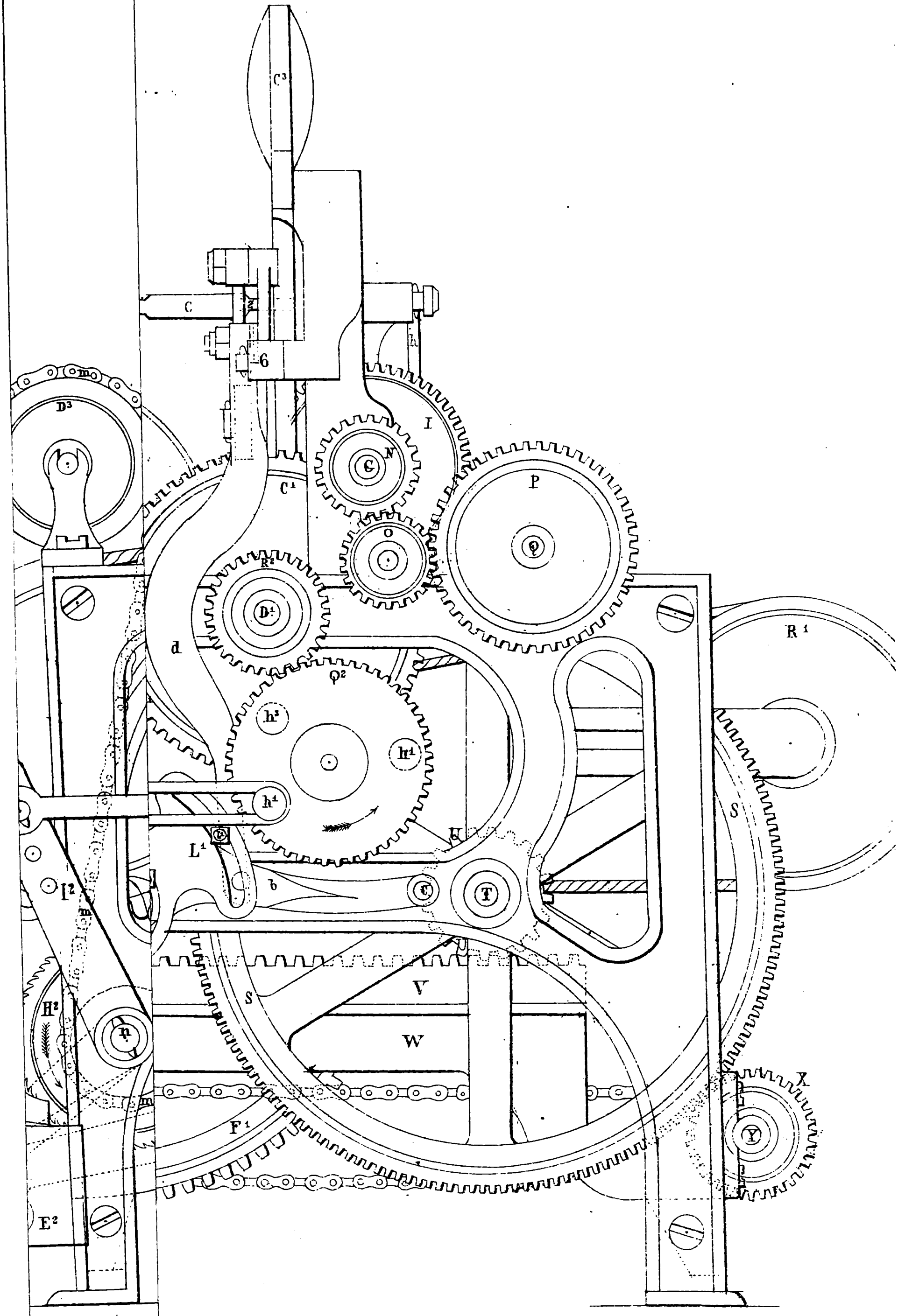
Fig: 1.

COTTON SPINNER

P. S. Duval's Steam Lith. Press

Plate III.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P. S. Duval's Steam Lith. Press.

OTTC

MASON'S MULE.

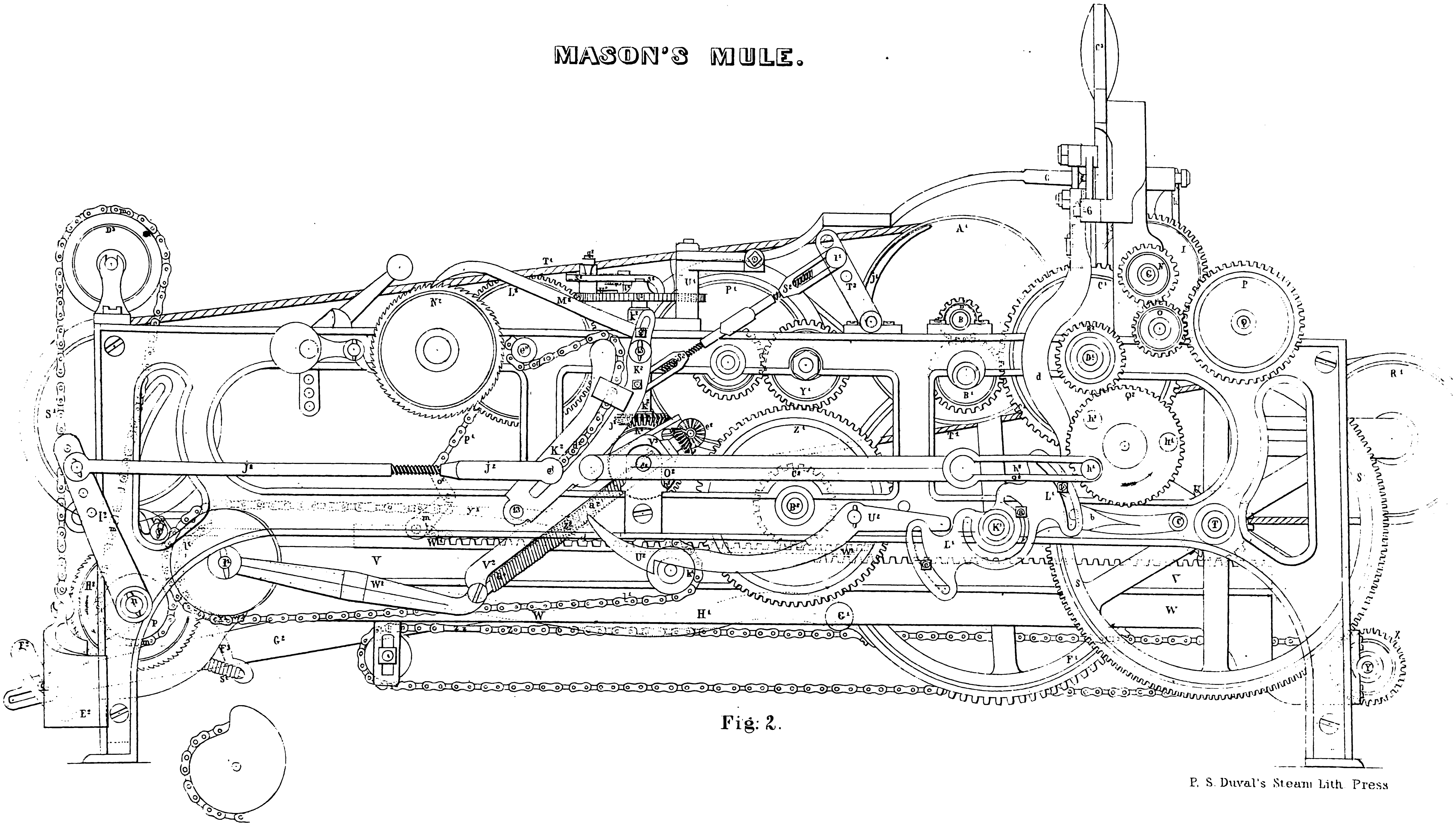
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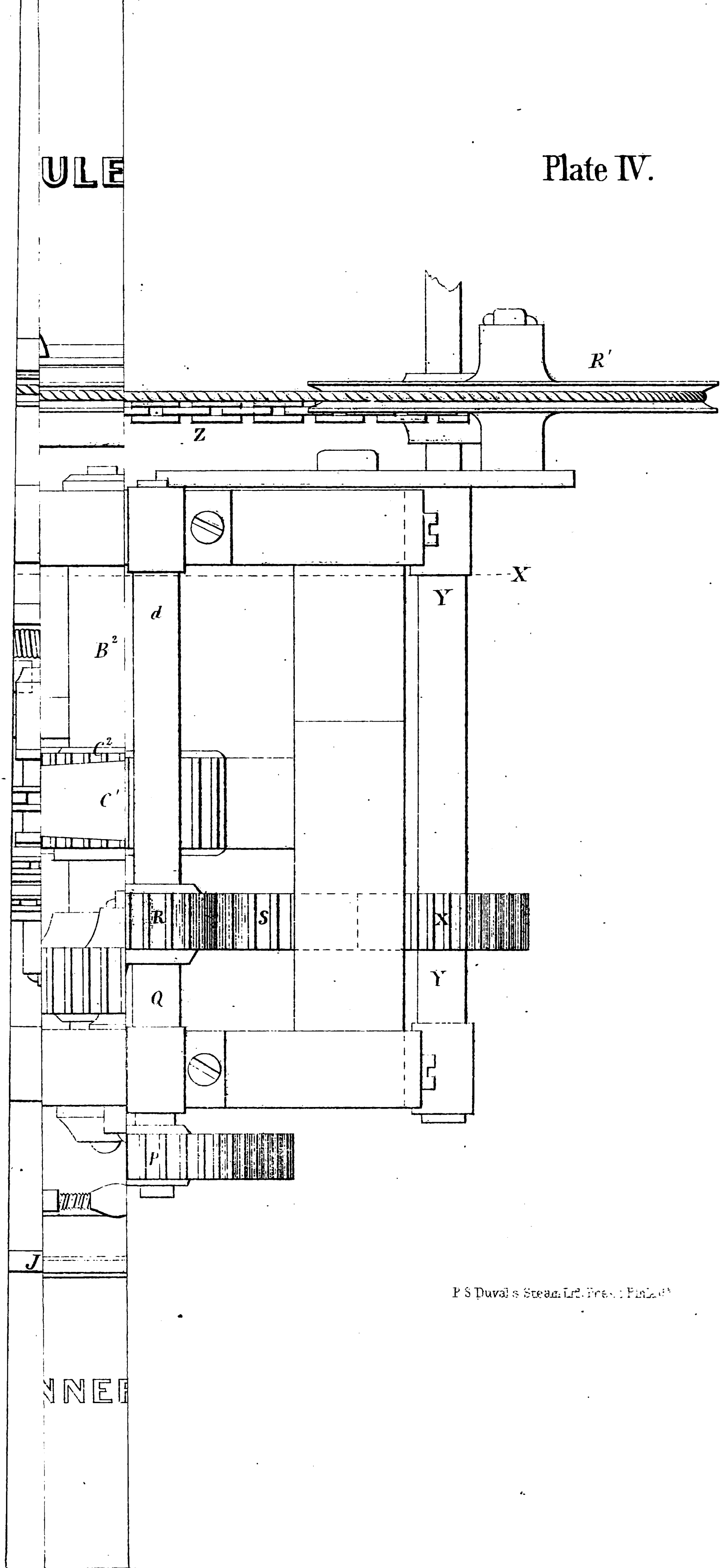
Fig: 2.

P. S. Duval's Steam Lith. Press

Plate IV.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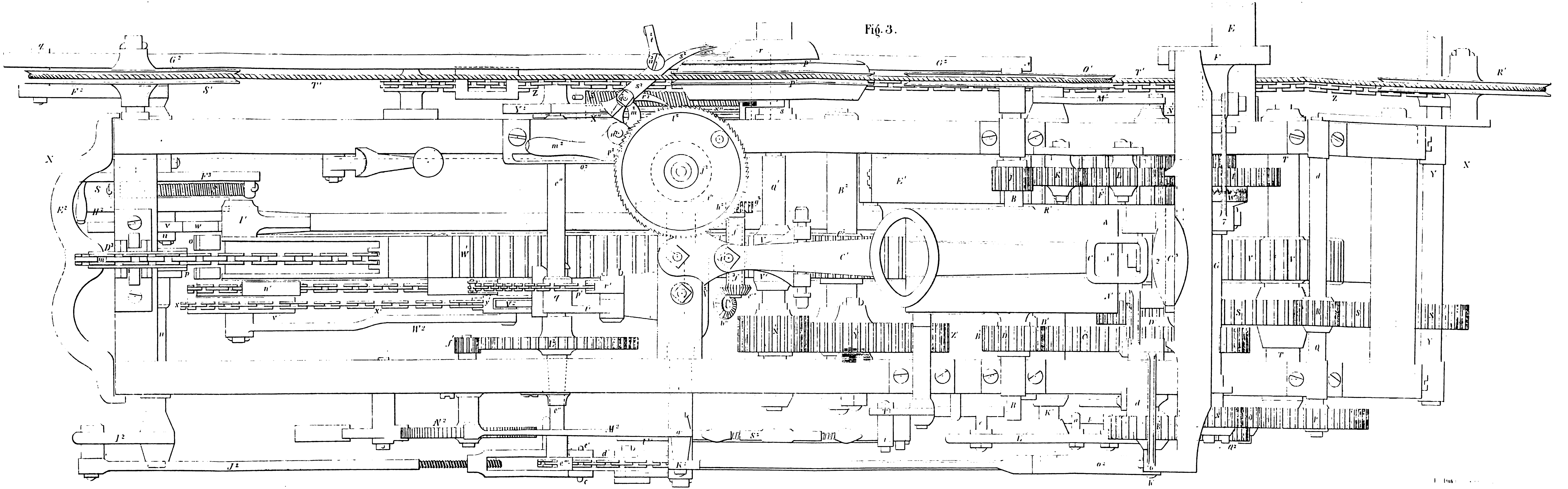
P S Duval's Steam Lith. Press Philad^a

MASON'S MULE.

Plate IV.

Fig. 3.



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COTTON SPINNER.

Plate V.

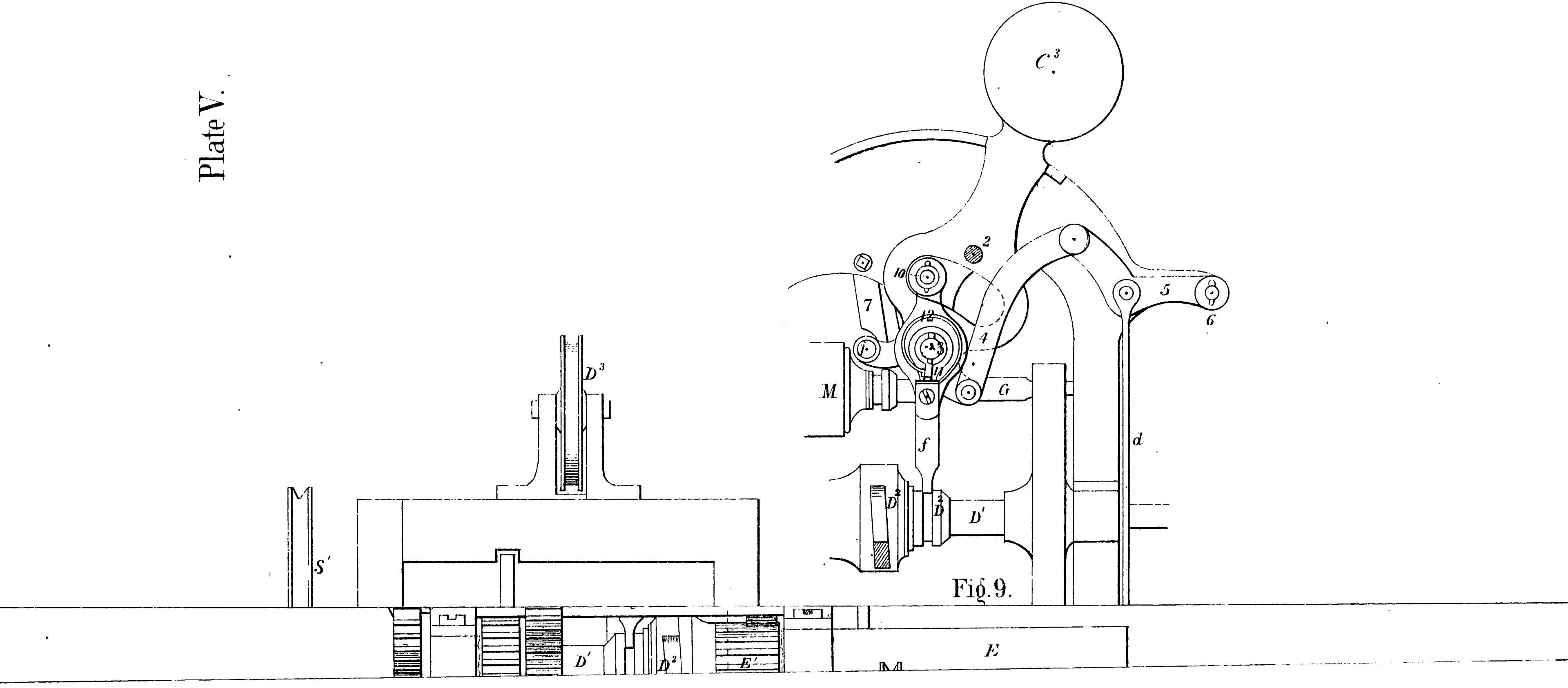
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Fig. 9.

Plate V.

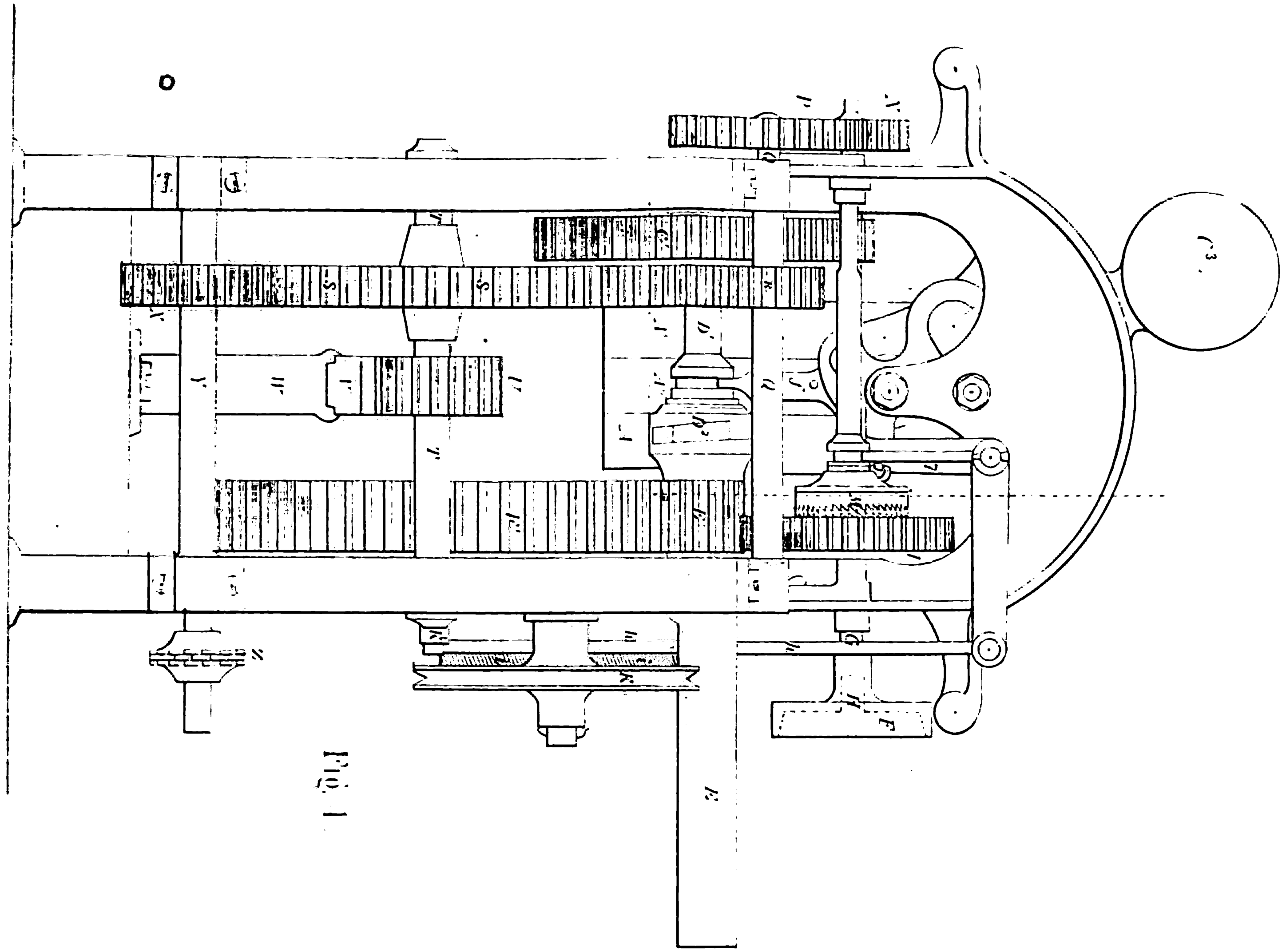


Fig. 1

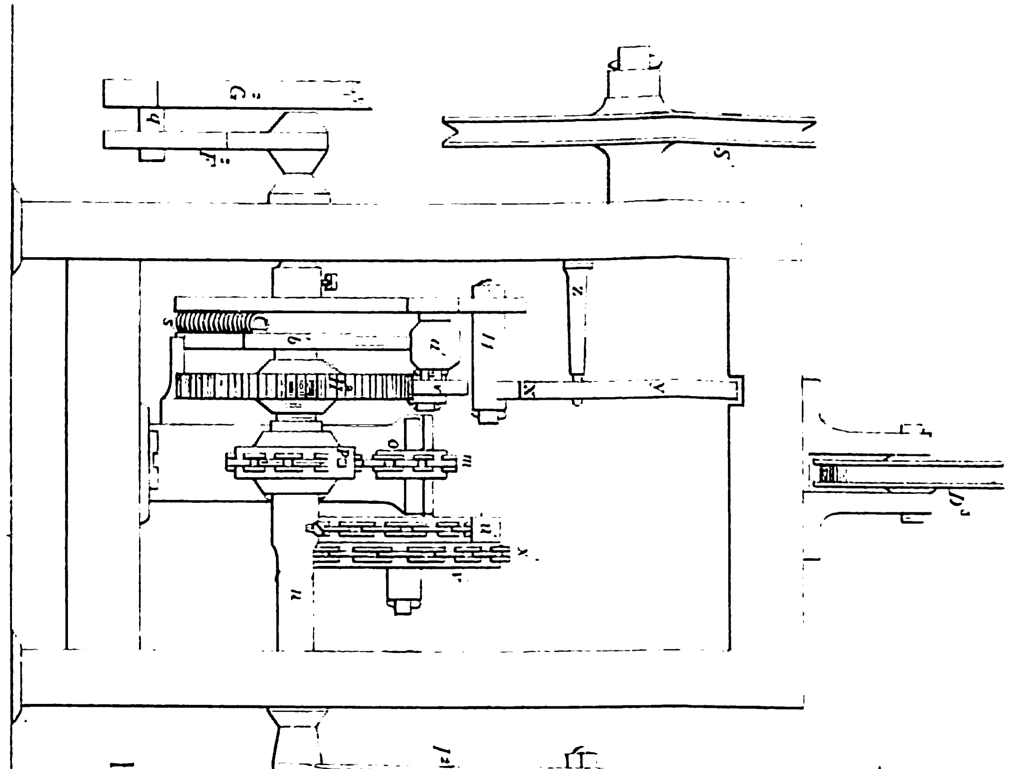


Fig. 6.

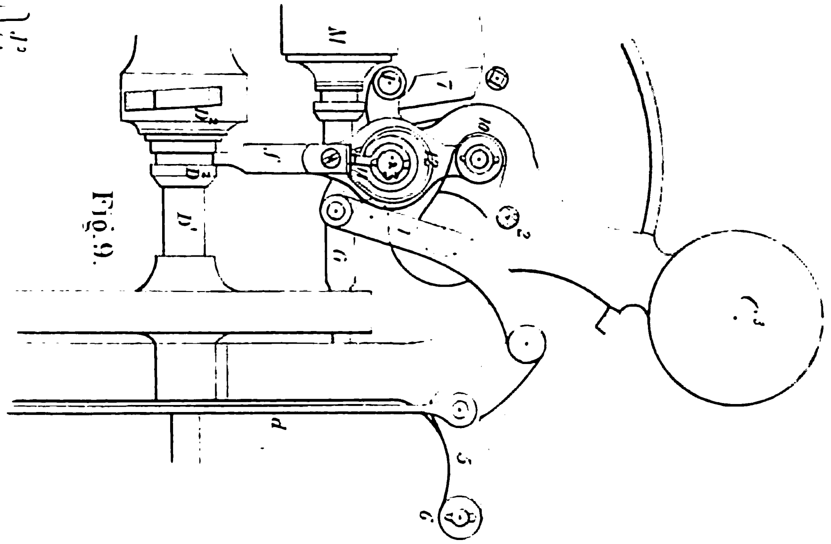
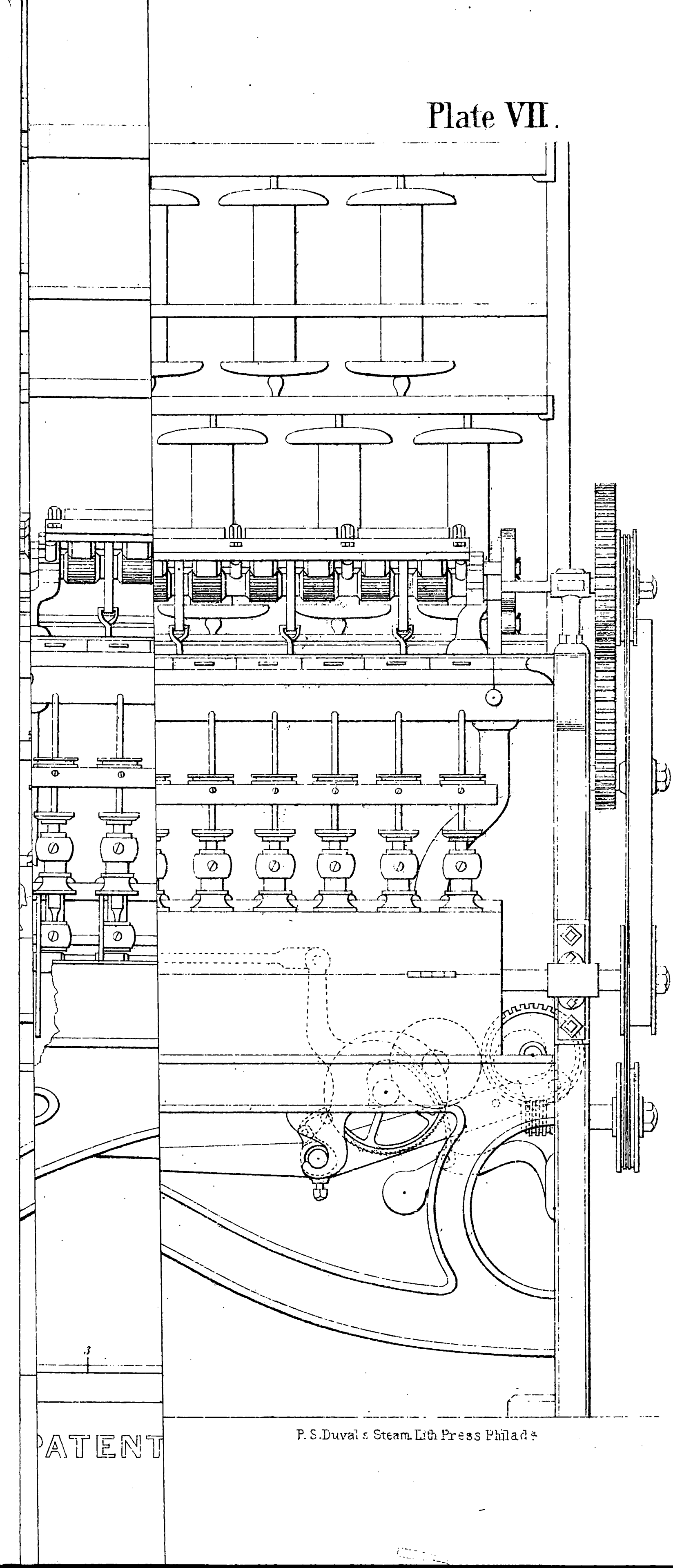


Fig. 9.

COTTON SPINNER.

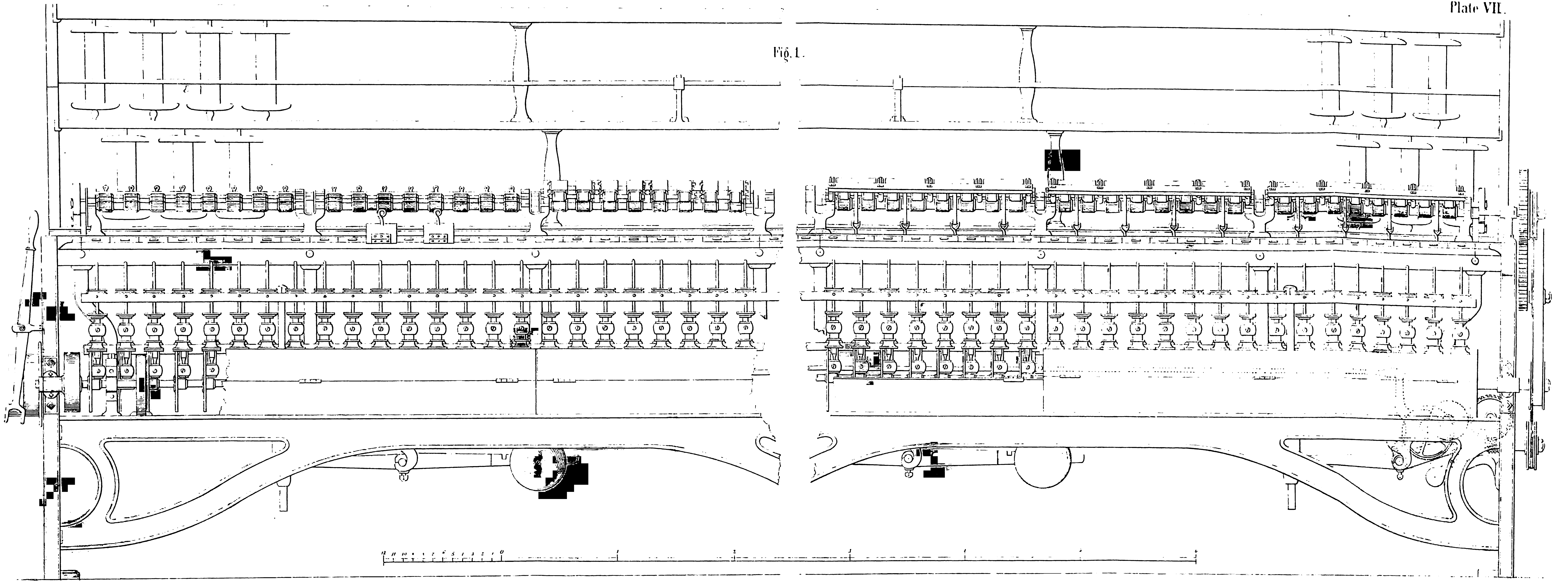
Plate VII.



P. S. Duval's Steam Lith Press Philad^a

Plate VII.

Fig. 1.



COTTON SPINNER.

RING THROSTLE Mc CULLEY'S PATENT LIVE SPINDLE.

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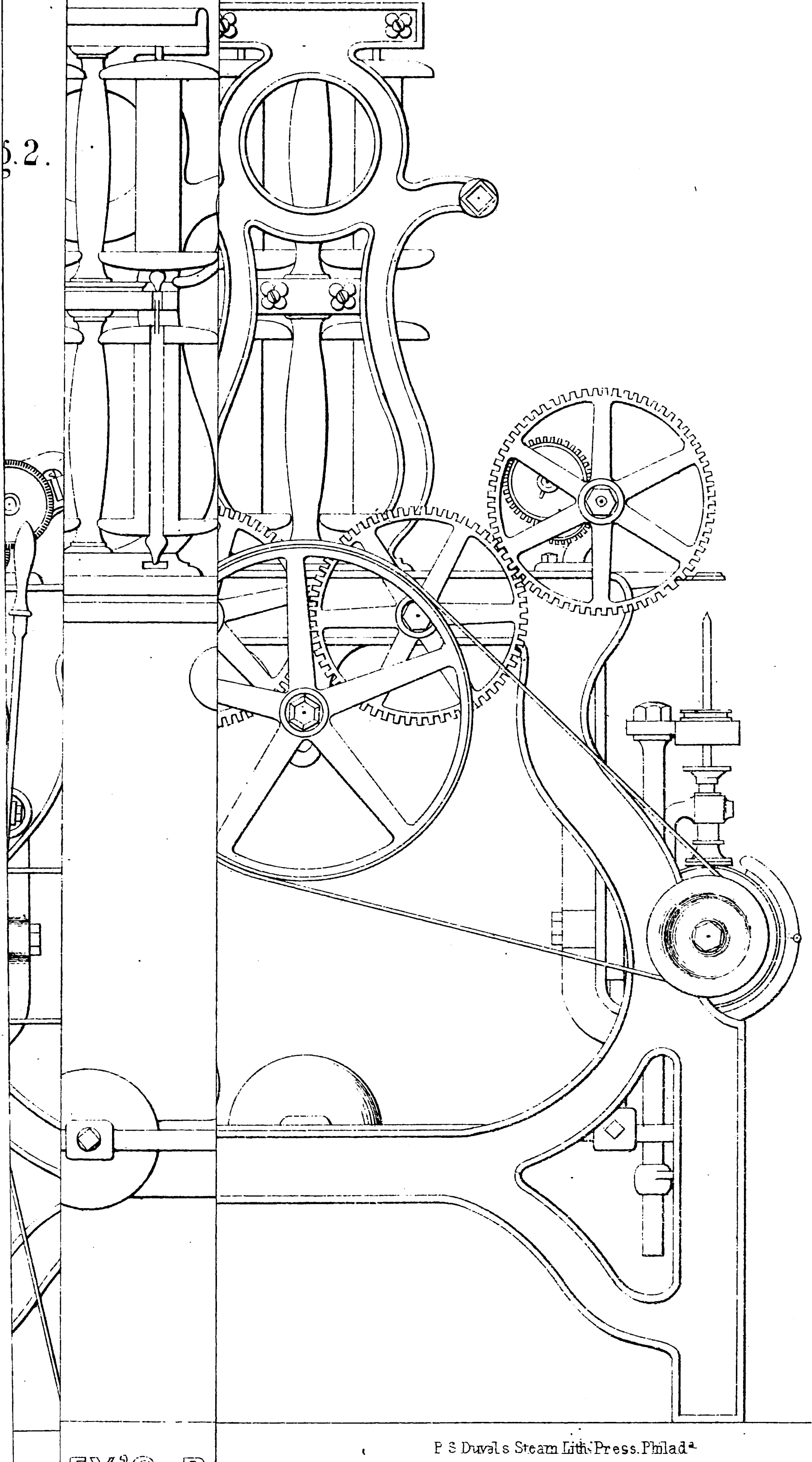
Plate VIII.



P. S. Duval's Steam Lith. Press. Philada.

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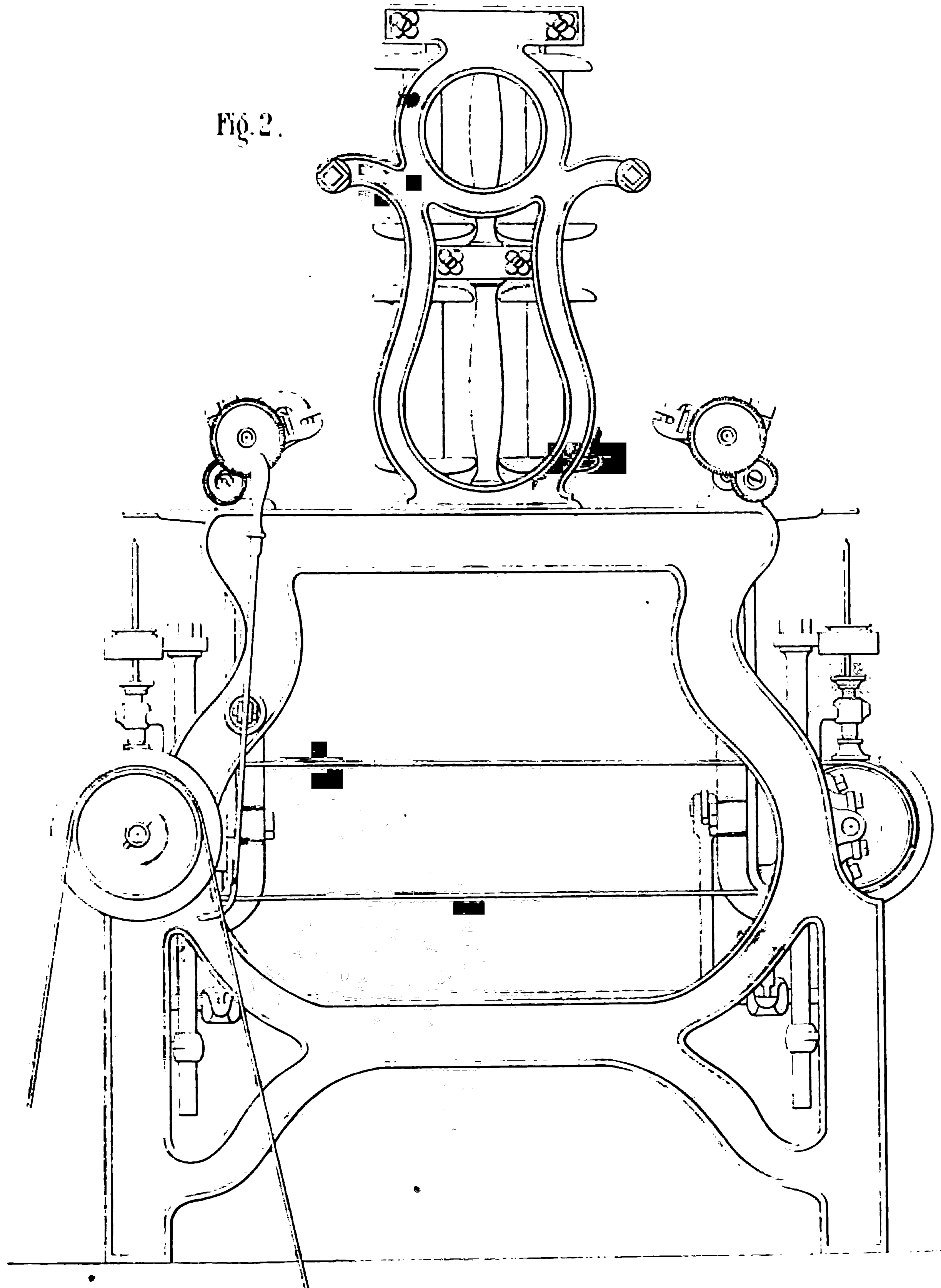
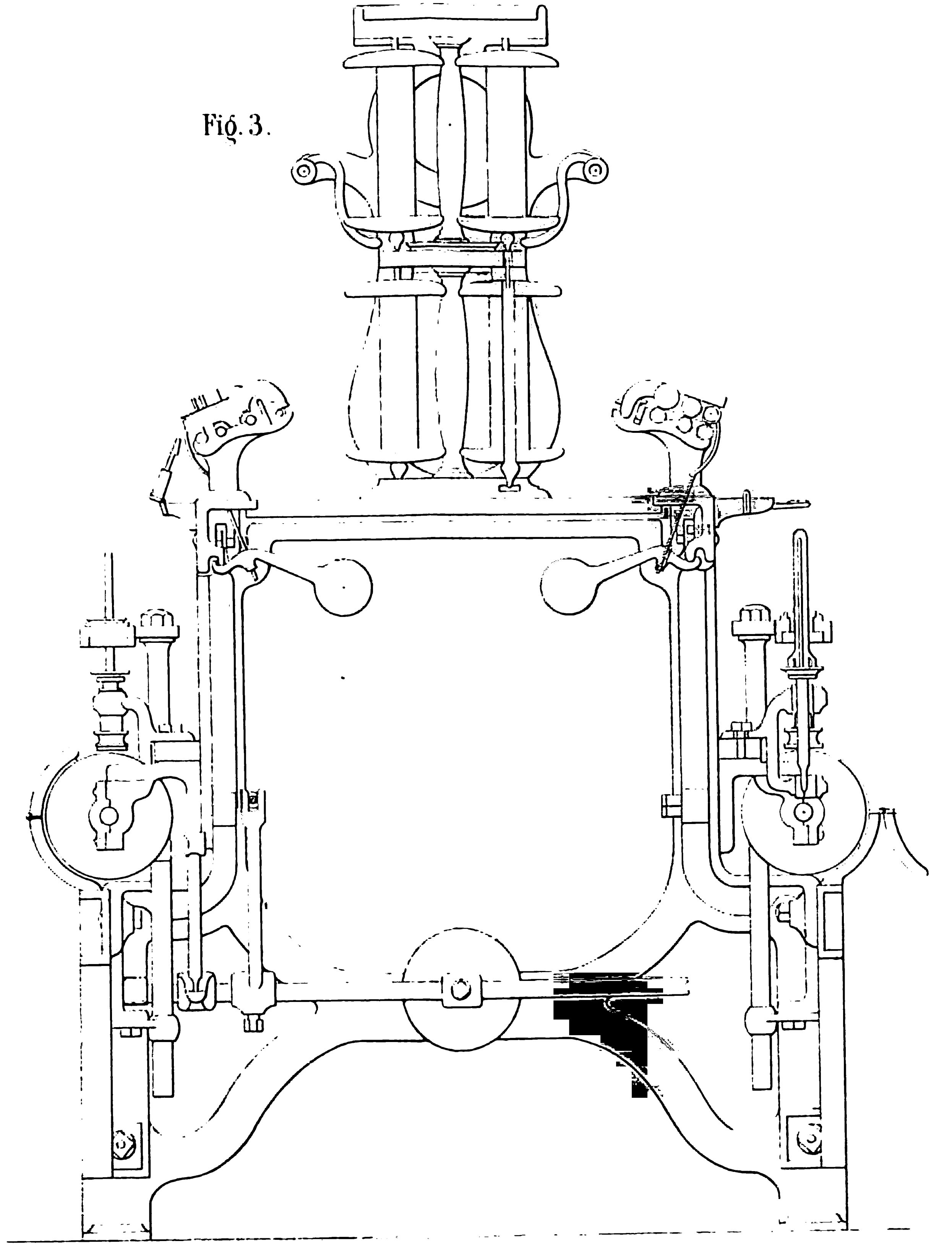
Fig. 2.



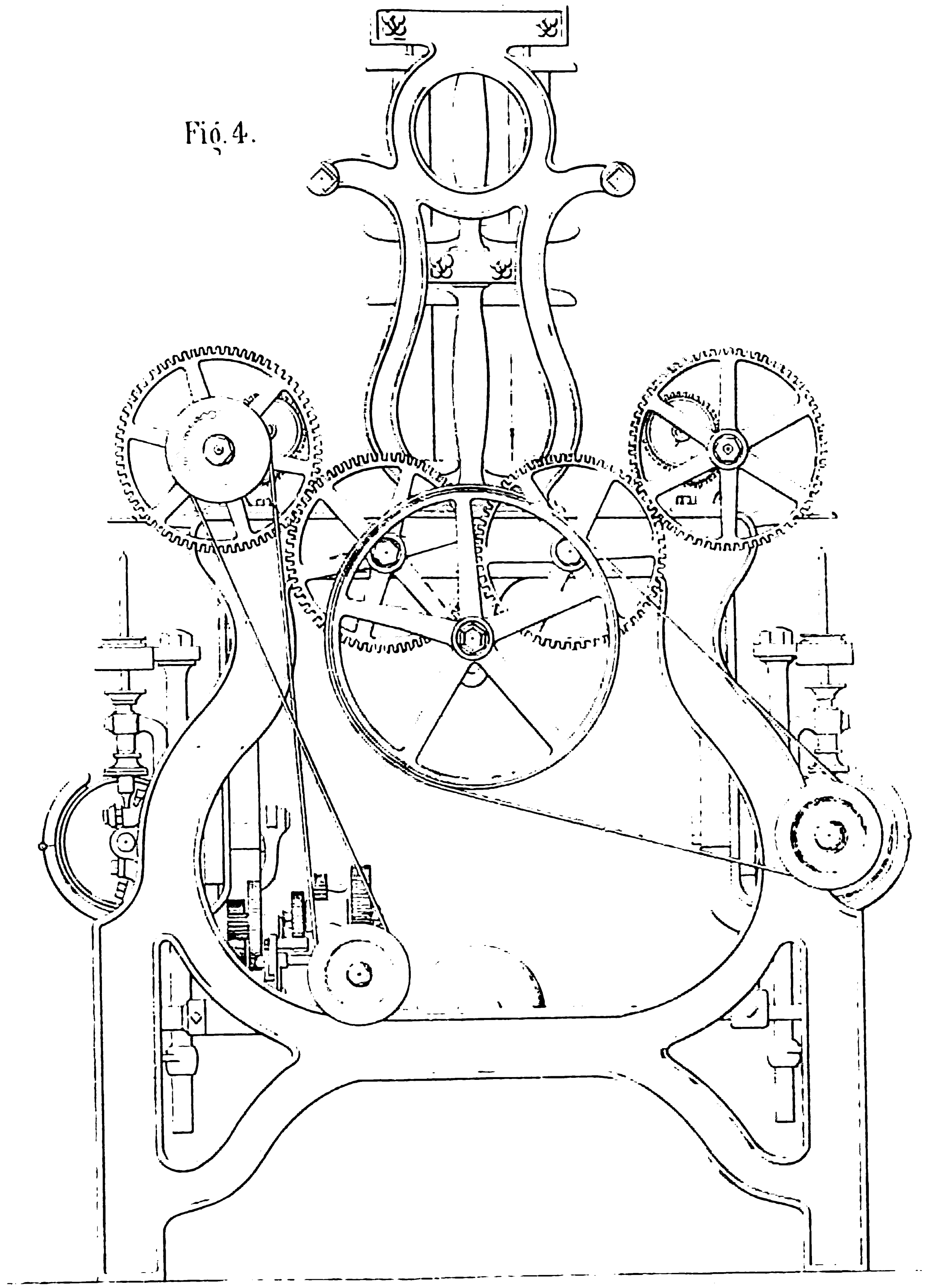
COTTON SPINNER.

Fig. 3.



RING THROSTLE, McCULLEY'S PATENT LIVESPINDLE.

Fig. 4.



[illegible] Steam Lith. Press Philada

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TO THE

PRACTICAL MODEL CALCULATOR,

BY

OLIVER BYRNE,

CIVIL, MILITARY, AND MECHANICAL ENGINEER.

PHILADELPHIA:
PUBLISHED BY HENRY CAREY BAIRD,
(SUCCESSOR TO E. L. CAREY,)
SOUTH-EAST CORNER MARKET AND FIFTH STREETS.
1851.

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